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THE INTER-RELATION OF THE MEDICAL SCIENCES[1]

SECTION N of the American Association for the Advancement of Science has for its field the medical sciences. I do not know that in this organization the question what are the medical sciences has ever been raised or discussed. I take it, however, that it is generally assumed that the medical sciences include at least human anatomy and human physiology. At any rate, the workers in these fields find no home in this association except in this section. It is also taken for granted that among the medical sciences are included all the myriad branches of medicine, many of which have sprung into being during recent decades. Recently it has almost seemed that whenever two or three have gathered together to deal with a special medical problem, the suffix o-l-o-g-y has been added to the name of the subject treated, and a new science has been born.

To the practical American there seems to be little value in attempting a rigid classification of the sciences, such as has been attempted by Bacon, Spencer, Karl Pearson and others. Yet any serious consideration of the various sciences and of their interrelations may make us realize how much we take for granted and how illogical in many respects is the present situation.

From its derivation, the term medicine has to do strictly with healing, and the term designates either the agent employed in healing or the branch of knowledge which has to do with the prevention, cure or alleviation of human disease. It is obvious, however, that in spite of this definition medicine has come to mean something much more inclusive than therapeutics. If it does not this section is dealing with the application of science, not science itself, even though various sciences are contributing to it. It is true that the application of knowledge to practical ends neither lessens the importance of that knowledge nor lowers the dignity of him who so uses it. This association, however, is chiefly interested in the pursuit of knowledge, not its application. And in the striving after knowledge, experience has shown that any limitations, such as usefulness, placed upon the results of the searcher seriously handicap him in his

[1] Address of the vice-president and chairman of Section N—Medical Sciences, American Association for the Advancement of Science, Nashville, December, 1927.

effectiveness. The true scientist can not be restricted to the production of results that are immediately useful or even of results that may be useful in the future. Notwithstanding this, we suspect that every scientist, even the most pure, cherishes a secret hope that his results will receive an early application, and the question may even be raised whether every searcher after truth is not stimulated in his endeavors by the consciousness that his contributions are bound in the end to contribute to the well being of mankind. But if scientists have a dogma, it is that the advancement of knowledge can best be accomplished by pursuing it quite independently of any immediate results, and if this association has a slogan, it should be, "Unrestricted Investigation."

For many centuries medicine has suffered from the restrictions implied in the term. At present these may be more imaginary than real, but, at least in the past, these restrictions have exerted an inhibiting influence even on the development of therapeutics itself, and have exerted a still greater inhibition on the growth of knowledge, concerning the real nature of disease in man, and also on knowledge regarding the structure and functions of man in health. These restrictions are partly inherent in the nature of the subject, but to a greater degree they have arisen as a result of the historical development of the organization through which this branch of knowledge has been cultivated.

Man's first interest in disease undoubtedly arose from a desire for relief. When he became conscious of an unusual physical state, usually evidenced by discomfort or "dis-ease," he ascribed it to some supernatural agency, and appealed to the gods for relief. Later he found by chance that through the employment of certain physical agents, pain might be relieved, especially when the abnormal state was the result of some obvious external agency. The priests who were the intermediaries with the gods in relieving the mysterious ailments, also became the healers who applied the less mysterious remedies. Thus originated the healers or physicians, and from the earliest times to the present, physicians have been the custodians of knowledge concerning disease. But physicians have been employed by the sick to heal them, and the physicians therefore could not be entirely disinterested seekers after truth. Under these circumstances, it would not have been remarkable if any seeking for knowledge which physicians undertook, should always have been directed to a search for cure. The Hippocratic Oath expresses lofty moral principles and registers a vow to transmit the knowledge of the art to certain disciples, but it contains not a word about attempting to learn more about disease.

To facilitate the transmission of the curative art to others, schools of medicine were organized, and these later became incorporated in the universities. Knowledge of disease consisted in deductions made from principles, but these principles were based upon the crudest analogies. Even such a state of affairs, however, is eminently satisfying to certain types of the philosophical mind, I will not say to all. It is interesting, if not amusing, to read in the most recent history of medicine, in the introduction written by a philosopher-physician—"And so do we arrive at the paradox—true, as are all genuine paradoxes—that, when in the sixteenth century medicine was, as we should say, less "scientific" than to-day, medicine was indeed, as now it is not, a science in very truth." But for good or ill, and it is difficult for us to be convinced of the evil results, the desire did arise to obtain knowledge about disease which was not deduced from principles, but which was derived from actual first-hand observation. Since little could be known about abnormalities in structure and function until more was known about the normal state, it was only natural that physicians should have been led into the study of anatomy and physiology. It can not be maintained that this knowledge was pursued solely for the sake of curing disease, but the pursuit of this knowledge originated in, and was practically confined to, the medical schools, and the search was almost exclusively conducted by physicians. Vesalius was a physician and even he forsook his study of anatomy for the more lucrative post of physician to Charles V. That Vesalius was a physician and that Harvey was a physician do not detract from their contributions to science. Rather it emphasizes the pride that all members of the medical profession should have in the fact that these men broke away from pursuing an immediately useful object, and attempted to discover Nature's secrets. But in so doing Vesalius and Harvey forsook their field, they entered a new province, they no longer were studying disease, they were no longer studying abnormalities in structure and function; they were studying the normal, the usual. Certain men like Leonardo da Vinci possibly undertook the study of anatomy chiefly to satisfy an insatiable curiosity. But even Leonardo was undoubtedly led to peer beneath the surface, at least partly, through a desire to be better able to depict the human form. Theoretically the study of human anatomy might just as well have been incorporated in the schools of art, but it was not to be, and, from the sixteenth century until to-day, the cultivation of the science of anatomy has occurred almost exclusively in the medical schools. It is only within our own day that those teaching and studying this subject and widening its boundaries, have not at the same time been engaged in applying

remedies, healing the sick. True it is that in the halcyon days of the fifteenth and sixteenth and seventeenth centuries the searcher after truth could ramble over the whole field of nature, and pluck flowers wherever he went. The investigator did not have far to go to encounter the unknown, it lay all about him. And very many of the searchers of these centuries were physicians. Paracelsus and his followers, Van Helmont and Stahl, knocking at the door of chemistry, were physicians; Galileo and Gilbert, Copernicus, and numerous others were trained in the art of medicine and many of them practiced it. But whereas physics, at an early day, and chemistry, somewhat later, were divorced from the medical school and were given independent positions in the universities, human anatomy and human physiology retained their incorporation in the medical school, and to this day they have never gained their independence. They are still called medical sciences and have had to bear the burden imposed upon them, by implication at least, of pursuing knowledge for a definite utilitarian purpose. Whatever the situation may be to-day, in the past this burden has too often been more than merely that imposed by implication, it has been a real impediment, sufficient actually to hamper the growth of these sciences. To-day anatomy and physiology are thriving best where they are most free from the restrictions enforced upon them through their inclusion in the medical school. These restrictions are not all associated with the relation of medicine to cure, however. Certain restrictions in the medical school have arisen from the attempt to provide a too rigid and all inclusive curriculum which expresses the antithesis of the university spirit. In England histology or microscopical anatomy is still taught in the department of physiology, to the detriment of anatomy. On the other hand, it must be admitted that in certain medical schools, in this country at least, the attitude is becoming much more liberal. Anatomy is becoming less and less restricted to pure description. We even have professors of physiological anatomy!

What has been said about anatomy and physiology refers to human anatomy and to human physiology. The study of structure and function in what we call the lower animals took a different course. It is to Aristotle that science owes the beginning of zoology, comparative anatomy and embryology. Although Aristotle's father was a physician, and although Aristotle is sometimes spoken of as an Asclepiad, and his enemies accused him of practicing medicine, he took little interest in medicine, and he is said to have produced but one medical work and that one is now lost. As Allbutt says, "Hippocratic physicians accumulated a remarkable series of facts . . . but their work was not, as that of Aristotle, for disinterested science but for practical ends." Ever since Aristotle the study of anatomy, physiology and embryology of animals other than man has not been relegated solely to the medical schools nor been exclusively engaged in by physicians, and this in spite of the fact that these subjects have a very direct relationship to human anatomy and physiology and medicine. Whether this separation from medicine has influenced the growth of these sciences, I do not feel competent to judge, but one may at least say that the followers of these sciences have made distinctly greater contributions to biological theories, and have had more influence in establishing biological principles than have the followers of human anatomy and human physiology.

When physicians became conscious of a desire to extend knowledge, their natural and legitimate field was disease itself. It is true that ever since Hippocrates, physicians had been attempting to describe and classify disease, so far as this could be done by mere observation of symptoms. But, of course, this was but the first step in arriving at any real understanding of disease. It was a long time after the beginning of anatomy before physicians began to make any serious investigation of the abnormalities in structure resulting from disease, at least before morbid anatomy consisted of more than fragmentary observations. It was two hundred years from Vesalius to Morgagni. One may say that only then did physicians begin to be scientists in the modern sense. The high aspirations of pathological anatomy is indicated by the title of Morgagni's monumental work, *De Sedibus et Causis Morborum*, though the title indicates a much greater confidence in the results to be obtained from the mere description of lesions than was justified. At first pathological anatomy was studied and taught by the anatomists, but later, to its great advantage, it became more closely integrated with clinical medicine, that is with the study of the manifestations of disease in the patient during life. As Billroth says, "The new material became vitalized only when the clinical physicians took hold of it and either themselves undertook the dissections or had them performed under their direction." But pathological anatomy, I will not say its followers, became proud, and pathological anatomy became pathology, the science of disease; its votaries became pathologists, and, in this country at least, pathologists they have remained to this day. That this assumption of exclusiveness was justified, no one will claim, for even the most ardent followers of this branch of knowledge must admit that alterations in structure alone can give but a very imperfect conception of disease. If the pathologists, in assuming their new

title, were animated by a desire to escape from the restrictions imposed upon medicine by the necessity of obtaining useful results, of promoting cures, no one can blame them. But the separation of pathological anatomy from the study of disease as a whole was neither good for pathological anatomy nor for medicine. Pathological anatomy or pathology, or whatever we call it, is not one of the medical sciences, or a contributory science to medicine. It is a part of medicine itself, unless medicine is to be restricted to the cure of disease. The science of medicine is no more applied pathology than pathological anatomy itself is applied anatomy and histology. The study of pathological anatomy is, or should be, only one of the methods for investigating disease, and the closer it can be interwoven with the other methods the more likely are its results to be of value. The field of pathological anatomy is the study of the effects of disease. To really learn about disease, that is to understand the alterations in function and structure which are exhibited by the abnormal individual, the individual himself must be studied, during life as well as after death, and this study must be combined with an attempt to explain the abnormal phenomena in the light of present knowledge and by the aid of all suitable methods. This is the science of medicine, if such there is, and if there is not such a science there ought to be.

The first and essential step in the pursuit of knowledge concerning disease consists in describing and classifying the phenomena to be studied, and that must be done by observing sick individuals. Disease is not something that exists apart from the patient. Knowledge was long retarded by considering that diseases were entities. Upon the seekers after this kind of knowledge the burdens of utilitarianism bear of necessity more heavily than they do on the followers of anatomy and physiology, or indeed on the votaries of any other science. They can not be entirely escaped. We may study earthquakes, or tides, or the natural attraction of bodies for one another as these phenomena present themselves. Certain phenomena we may reproduce at will. But in the study of disease in man we can not investigate the phenomena with hands off. We must always interfere by attempting to prevent harmful results. Moreover we are powerless to reproduce the phenomena artificially. The science of medicine is not analogous to theology but to demonology, and the restraints of morality, of religion, of conscience will not permit one to study these demons without attempting to cast them out and to destroy them. But one can do both things if he is not controlled entirely by his emotions, or worse by the temptations of self interest, and these are great indeed, but if he is also inspired by curiosity and controlled by reason. The true student of medicine must realize that before disease can be cured it must be understood. And to understand it, it must be studied at the bedside, in the laboratory and at the autopsy table. Clinical medicine, or whatever the study of the more superficial aspects of disease may be called, experimental medicine, pathological anatomy, pathological physiology, are but different aspects of the same thing, the study of disease, the science of medicine. Practical results in the way of cure are bound to follow the development of this science, but these must be the natural outcome, not the objects to be always held in view. Even therapeutics may be pursued in the spirit of a pure science, as witness the growth of pharmacology, which has flourished best and has been most productive when it has attempted to learn, not how to cure patients, but has investigated the action of drugs in producing alterations in function. It thus becomes a matter of emphasis as to whether medicine will be merely an applied science or not.

It must not be assumed, however, that the pursuit of practical ends precludes the advancement of knowledge. The reaction against the Baconian philosophy is not entirely justified. When we are tempted to disparage, let us remember that Bacon's spirit was responsible for the formation of the Royal Society. It would be a rash man who would belittle Pasteur as a scientist, yet most of his work consisted in pursuing very practical ends, and at least one of his two or three fundamental contributions was the direct outcome of an attempt to obtain a utilitarian result. That scientists will obtain useful results goes without saying. That they should not be under any obligations to obtain immediately useful results, and that their work should not be judged by any criterion of utility, experience seems to have shown.

The methods and accumulated results of all sciences must be used in pursuing the science of medicine. That some of these sciences are more closely related to medicine, in their methods and fields of endeavor, than are others is obvious. Biology, comparative anatomy, embryology, bacteriology, protozoology, certain branches of botany, anthropology, human anatomy, human physiology, psychology, and even certain aspects of the social sciences, have many close affiliations with medicine. The methods of the more general and fundamental sciences, mathematics, physics and chemistry become applicable in any science as that science develops, and the degree of development of any branch of science may be tested by the extent to which the fundamental concepts of physics and chemistry may be usefully employed in its pursuit. That biology is ready for such an approach, the development of general physiology bears witness.

That problems of disease may profitably be investigated by the employment of accurate quantitative methods, and be studied in relation to the laws of physics and chemistry, is evidence that the science of medicine already exists and that it has even grown out of its swaddling clothes. But none of these contributing sciences are medical sciences. None of them should be trammeled by serving medicine alone. The only medical science is the science of medicine itself, that is, the science whose field is the study of disease.

Thus far I have not referred to the large number of subjects which, in so far as they receive any scientific treatment at all, are parts of the science of medicine. These are subjects, such as neurology, psychiatry, dermatology, otology, cardiology, angiology, gastro-enterology and so on, *ad infinitum*. On the other hand, there is another group of subjects which are held to be closely related to medicine, but which belong, so far as they belong in any science at all, in some one of the other fundamental sciences. I refer to subjects like histology, cytology, immunology, endocrinology, climatology, radiology and so forth and so on. The multiplicity of these terms illustrates the extent of what we may call growth at the periphery of a science.

It must be admitted that the science of medicine has not reached a high state of development, even such as physiology has attained. And furthermore, we must admit that many of the most important contributions to this science have been made by workers in related fields. Nevertheless, I believe that its greatest advancement will come only when it shall be pursued by men whose primary interest is in disease. Important contributions have been made by clinicians, but only comparatively recently have any considerable number of physicians become conscious of their obligations to contribute to this science, and only still more recently have physicians been given any relief from the burdens of practice which will give them opportunities for studying disease by scientific methods. It is true that many of the contributors to other branches of science also teach, but the practice of medicine is a much more time- and energy-consuming occupation than is teaching.

From the philosophical standpoint, from which the object of all science is but to obtain an interpretation of nature as a whole, it is possible that medicine may be relatively unimportant. It may be, however, that the most important generalizations will proceed not from the study of the normal but from the investigation of the unusual. The object of all science is to reach underlying principles or laws. As Priestly said, "Science is an effort to compress as much knowledge as possible in the smallest compass." And Karl Pearson said, "Nobody believes now that science explains anything; we all look upon it as a short-hand description, as an economy of thought." A great mass of knowledge about the details of disease has been accumulated, and this knowledge is about as accurate as it is in the other domains of biology. This kind of knowledge in recent years has been extending at an enormous rate. Journals devoted to medicine in its various aspects number many hundreds. The science of medicine is developing centrifugally, not centripetally. One important reason for this is that it is so greatly exposed to utilitarian demands. In his efforts to be aware of all the facts the physician has no time for contemplation of their meaning. In his fear of overlooking that which may be of value in prolonging the life of the individual, he fails to discover that which may be of importance for the race. We even lack accurate definitions of disease, injury, recovery, death. Possibly such definitions can never be made. Scientists are not so sanguine as they once were of reducing knowledge of the universe to formulae. But the science of medicine, as all other sciences, demands that efforts be made in this direction. In spite of all that has been said, however, the heterogeneity that exists in the knowledge about disease is no greater than that in some other branches of knowledge, the scientific status of which is never questioned.

Medicine occupies a peculiar position among the sciences. By workers in other fields of science, medicine has been looked upon askance, even disregarded. In most of the classifications of science it is not even mentioned. It is even claimed that there is no such thing as a science of medicine. On the one hand, as medicine, it has been scorned and neglected, and on the other, as the medical sciences, it has been honored and respected, and held to embrace within its borders such important divisions of science as anatomy and physiology, and the name has been used to designate an important section in this association.

Every organization must have a function. There seem in the past to have been some doubts as to what the function of Section N really is. May not one of its functions at least, be the support and promotion of the science of medicine, even though Section N continues to be called the Section of Medical Sciences. On behalf of human anatomy and human physiology, however, although I have no authority to speak for them, I should be glad to see this section called the Section of Human Anatomy, Physiology and Medicine, or the Section of Medicine and Related Sciences.

The support and defense of the science of medicine is needed, the battle is not to be easily won, the result is not certain. Apart from the opposition of those who see in medicine only an art pursued for practical ends, and aside from the inertia, arising from tradi-

tional viewpoints, as exhibited in the treatment of medicine in the universities, there is the question that is bound to be raised as to whether the scientific method is, after all, the most effective one for the advancement of knowledge in this particular realm. Great advances have undoubtedly been made in this field through a purely empirical approach. The Nobel prize has just been awarded for a discovery in this field which was not made through what is considered the scientific method. This association believes, however, that the best approach to knowledge is through the gateway of science.

The science of medicine requires workers imbued with the scientific spirit. Opportunities must be available for men who want to learn about disease. These men must be stimulated, and their work given appreciative recognition by workers in better established fields. The bestowal of this recognition and stimulation offers one way in which science may be advanced by this fellowship of scientists.

In what has been said I have merely tried to give expression to what has already been in the minds of most of us. The programs of recent years, and the program of to-day, indicate that the motivating force in this society is the promotion of scientific medicine. Through the efforts of this organization may medicine ever become more scientific, to the great blessing of mankind.

RUFUS COLE

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH

TOO LITTLE MATHEMATICS—AND TOO MUCH[1]

IN speaking on a subject like mine of to-night it is necessary to proceed by classification, for what might be too little mathematics for some groups of students could well be too much for others.

First let us consider those who contemplate becoming professional mathematicians. These form a negligible group—negligible in numbers compared with all those who should take some collegiate mathematics, negligible for purposes of instruction because each will go more or less his own precocious way. It is improper for any department selfishly to lay its plan of teaching for the rare Galois or Gauss or Abel, or even for the commoner Richardson or Archibald or Wilson. The future professional who is worth his salt will get along somehow without much of our assistance and possibly even in spite of it. He will follow the courses he wants and make up his deficiencies by private study. The professional knows how to learn, and in mathematics he knows it young. There will be small chance that he have too little mathematics; you may think he can hardly have too much. Herein I should differ with you and maintain that his real danger is "too much." I do not, of course, refer to what he will have learned or may have forgotten by the time he comes to a ripe old age or even by the time he reaches middle life; I am speaking of the future professional mathematician as a student, first collegiate and then graduate. He should not be stuffed with courses until his brain has become a glorified paté de fois gras. That would deaden his originality, doubly diminish his ingenuity, and thus triply hinder his development as a true professional.

Our American university departments sin greatly in the great array of prerequisite specialized courses which they offer and expect their students to take. The aim of any advanced course should be to line out a straight path from relatively elementary work to the research line. When I was in Paris I took a course at the Sorbonne on the dynamical theory of light with Boussinesq. He did not hesitate to take his time to explain that $\cos(\pi - x)$ equals $-\cos x$ or to prove some ordinary proposition in solid analytical geometry or to integrate some common differential equation, and yet in 60 lectures he reached material to be found only in his own recent papers. When I asked him why he took the time to prove so many elementary theorems he said that it did the students good to see such propositions demonstrated and that he had a superabundance of time anyhow. Such a course in any one of many fields could be given in our American colleges to seniors who had had three consecutive years of mathematics, if only our teachers had the finesse to give it. A book must be somewhat encyclopedic; a course should be selective, eclectic, for the purpose of helping the student quickly to an original problem upon which he may go to work. You have here at Brown one of the best collegiate departments of mathematics in the United States; you have an able staff; you need not hesitate to offer the doctorate. What you may miss is encyclopedicity, you will for that very reason the more easily make up in the freshness and promptness with which you start on original investigation.

Let us turn from the future professional to the ordinary college man. He may well have too little mathematics, too little for his own future comfort. The college student of inorganic chemistry of 30 years ago who failed to take a good course in calculus has paid heavily for this omission. It has much increased his difficulties in physical chemistry, in the work of van't Hoff and of Nernst, of Lewis

[1] Read before the Mathematical Club of Brown University.

and of Debye. For even longer any one who expected to go on into physics, astronomy or engineering should have had his calculus. To-day the physiologist, the bacteriologist, the biologist, and the student of the public health is reaching problems which require some mathematical insight for their elucidation, and the college student of to-day can scarcely fail to find himself seriously handicapped before middle life if he enters upon any of these fields without a college course in calculus. For many, many years not only arithmetic but algebra and geometry have been regarded as so fundamental in all education both for their own sake and for their uses in other studies that they have been required for entrance to college and have been widely taught even to those who did not plan to go to college. It may to-day safely be said that calculus is for the college student what algebra and geometry are for the high school pupil—of necessity for future use in many a profession, of cultural value for many a student who does not contemplate a profession. So much can not be said of trigonometry—biology, chemistry, physiology, and those branches of business, of medicine and of the public health which depend on statistics hardly use a periodic function; it is the logarithm and exponential which are central. There is small use also for analytic geometry. Graphs we do find everywhere, but the art of deducing theorems by algebraic processes is for the most part special to pure mathematics.

There is real danger that the college student shall have too little mathematics. To-day more are taking too little than too much. Why this serious situation? We may find some light on it if we reflect on the case of the chemist now in middle life. Most likely he took a full year of mathematics in college. Thirty years ago in the great majority of our colleges he had no option but to take it. However he did not learn calculus unless he followed mathematics for two or even three years. In other words we may say that between his algebra of the preparatory school and the method of dealing with variable quantities that he needed there was intercalated by the habits of the mathematical teachers of those days one or two years of work which could at best be of very limited use to him. Conditions are better to-day. We generally get to some calculus in the freshman course. I feel, however, that our collegiate teachers of mathematics could well go somewhat further than they yet have gone in making straight and fair the path of the ordinary student to and through the elements of the calculus both differential and integral.

Now there are two aspects in almost all learning; there is the logical or intellectual side which deals with the meaning of a subject, which is chiefly emphasized in elementary geometry, and the technical or operational side, which is largely placed to the fore in algebra. You may be a first class technician without much understanding of the significance of a subject or you may have a fast intellectual grasp with a negligible technique; you may be a thinker or a doer. These two activities are not entirely antagonistic, to a considerable extent they reinforce each other. In far the greater part of our life we are technicians of one sort or another, we learn how to do certain things. We do not go about learning to walk by first studying our skeletal structure, our musculature, and the laws of the lever. Whenever we need to do something repeatedly with precision we face the problem of developing a technique. The billiard player does not spend his time studying Routh's Rigid Dynamics. He acquires a sort of automatism under voluntary control. We can do the same for factoring or for differentiating. But what is the use; the great majority of us do not take naturally to such pursuits any more than we do to billiards; we have little occasion to use formal mathematics except of the simplest.

It seems to me that one error in much teaching of mathematics for the majority of students is overemphasis on technical processes and correlative underattention to meanings. It is too much mathematics of one sort and too little of another. According to my experience it is very difficult to expect a student to learn good technique and to gain a clear understanding at the same time. I prefer to aim the first general collegiate course at the understanding and to follow this up for those who are to be engineers or mathematicians, physicists or astronomers, and for those who like mathematical operations for their own sake, by a stiff course in technique. Now if you are going to teach or to learn meanings of things, you must not be in a hurry, you must keep your self-possession of mind, you must dwell long on a variety of simple things. What is the problem of learning the calculus so that you may use its ideas in any one of a great variety of applications which may later confront you as chemist or physiologist, as economist or public health officer? You have to get a real understanding of rates and summations, of infinitesimals and infinites, of limits of quotients of two infinitesimals and of sums of an infinite number of infinitesimals. That is about all; it is not much, but it takes time and patience. It requires the avoidance of early generalization. Mathematicians have a fondness for general methods in instruction. They forget that in their own work they almost always use some ingenious special notion and rarely the most

general method they know. Not many of us naturally work with E. H. Moore's "General Analysis"! In teaching, one must keep the special to the fore and let the generalization come later as a union in a single view of a variety of specials already known. And in general, one must proceed from the known to the unknown. That is why review is constantly necessary, why the repetition of a demonstration from previous studies is not a waste of time, but actually a time-saver. We do not ourselves readily use that last thing we have learned any more than we use the most general; why expect of our students that which we have learned by experience we may not expect of ourselves? The breathlessness of American life is an index of indigestion. We are stuffed with the latest news, the most recent invention, the newest fad whether of mechanism or of dancing, of science or of sociology. We do not know what they mean, we do not even inquire what are their antecedents from which an inkling of their meaning might be learned. The classics have pretty much vanished from our instruction and science has not yet learned to replace them in poise and in perspective.

Perhaps I might without boring you go somewhat into detail about one way of introducing the few fundamental concepts along which those who need a little mathematical thinking may be led without too much involvement in formal operations. Begin with uniform velocity and its space-time graph of which that velocity is the slope. This is a better definition of slope than through the trigonometric tangent. Follow with uniform acceleration, treating variable velocity in the case of uniform variation as the innate concept that is. Point out the logical and geometrical identity between the relations of uniform acceleration to velocity and time and the relations of uniform velocity to space and time. As much of our fastest thinking is by analogy, it is well to emphasize true analogies. Proceed to deduce by any one of the old fashioned methods the relation between distance and time in uniformly accelerated motion. Then deduce the relation over again by a variation of the argument. Two proofs of one important central theorem which involves the most fundamental of notions give more power and understanding to the student than the proofs of two theorems of which only one is important. Dally over the properties of the quadratic or parabolic space time graph, $s = \frac{1}{2} at^2 + bt$, not so much for the importance of those properties in themselves as for their significance to uniformly accelerated motion. It is remarkable how simply some of the geometry of the parabola develops this way. The fact that any chord of a parabola is parallel to the tangent at the abscissa half way between those of the ends of the chord is but another statement of the proposition that in uniformly accelerated motion the velocity at the mid time of any interval is the mean velocity. That the tangents at the ends of a chord meet on this same mid abscissa means merely that you will cover the same distance whether you move with uniform acceleration or with the initial velocity for half the time and then with the final velocity for the remaining half. So too the fact that the line joining the intersection of two tangents to the mid point of their chord of contact is bisected by the parabola is simple kinematics. All this is helpful for reinforcing the meaning of things fundamental.

When you have reached this point you can hardly resist the temptation of solving the quadrature of the parabola by proving that the curve divides the triangle formed by two tangents and their chord of contact is the ratio 1:2. It is a mere corollary obtained by doubling up the construction, and so much simpler than the quadrature of the circle. There is no infinite series to sum; the construction at each step cuts off half as much on the outside as on the inside. And then you have Simpson's Rule. You can take your students back to the quadrature of the circle just for review and to show them how much harder it is. Moreover you have the indefinite quadrature of the parabola, whereas for the indefinite quadrature of the circle you need not merely π but the inverse trigonometric functions. However, you may be strong minded and able to resist this little excursion into quadrature. You could return to uniform velocity to discuss interpolation by proportional parts and then with the aid of uniform acceleration pass on to interpolation to second differences. This latter subject is often, perhaps generally, omitted from mathematical instruction. I have run across more than one candidate for the doctorate who did not know that the condition for safe interpolation with first differences is that the second differences are less than 4. It is true that second differences are not important for themselves; they are, I think, important for the insight they give into the behavior of infinitesimals, and to my mind the infinitesimal is the fundamental thing in calculus. I hold no brief against limits. They are necessary to clear thinking, including clear thinking about infinitesimals. I will not further go into detail, but merely point out that if the teacher has done a good job on uniform and on uniformly accelerated motion and on first and second differences, he is ready for definitions of limits, of infinitesimals, of derivatives and of integrals with the assurance that he has provided kinematical and arithmetic considerations on which those definitions may be cogently illus-

trated and subsequent developments may be safely built.[2]

My thesis is that if we are to encourage the general student, who ought to be encouraged, to take a little mathematics we should avoid subjects which will be of small use to him and in particular should emphasize ideas and simple applications of the calculus rather than inflict upon him from the start a vast operational technique. We should use simple concrete ingenious special methods instead of setting up general systems of analysis. In short we should consider the student somewhat in the light of our own daily experience properly written down to his present level. We must avoid giving him too much mathematics if we are fairly to expect him to avoid taking too little. According to my experience it is rare in departments of mathematics to hear such questions discussed. Indeed I sometimes think that around universities one seldom hears a discussion of any matter of education, of teaching; there is a lot about administration and about research, both of which I should suppose existed chiefly in the college for their reactions on teaching rather than for themselves. It may be that pedagogic questions are so far settled as no longer to need original and critical thought; at any rate, there is in the vast supply of text books produced by college professors much more of uniformity than in their research, and the uniformity is of a type which suggests a study of other recent and similar texts more than of the history of science, of the method of approach to new subjects, of the great texts of all time.

We have considered together the possibility of too little or of too much mathematics for the future professional and for the general student. Through the exigencies of the institutions in which I have worked, that is through opportunities which have arisen and which it has seemed desirable that I should meet, my course as a teacher has laid successively through modern geometry, mathematical physics, mechanics, aeronautics, physics and now rests in vital statistics. Statistics is peculiarly a subject in which too little or too much mathematics may be used and in which a golden mean is especially necessary to soundness of judgment. When I was in college one might find some astronomer teaching least squares as a method of reducing observations, some physicist lecturing on kinetic theory, some mathematician expounding probability; but statistics was practically unknown to the most varied curriculum. Indeed Yule's text appeared in its first edition only in the year 1899 of my graduation from Harvard. Now everything is changed. There are many courses undergraduate and professional on statistics and a new book comes out almost every other month. What is the intellectual level of these courses and these books? For the most part, so far as I can determine, that level is of the lowest, not comparable with pre-college mathematics or classics, about on a par with manual training. There are presented arrays of tabular material, of methods of calculation and of computation forms, without emphasis on logical analysis, still best represented by the 25-year-old text of Yule, without any substantial introduction to probability and chance, which except for logic gives the only firm foundation upon which to build an understanding of the difficult and treacherous science of statistics. It is as though you should teach applied mechanics without going into mechanics or physics or calculus. It is an exaggerated case of too little mathematics. Of course if our colleges and universities wish to train simple technicians in statistical methods who shall work their arithmometers under the direction of competent statisticians much as draftsmen work under designers, this absence of mathematics and of intellectual attention in statistics may be advantageous. But I take it that no considerable part of the students who follow statistics will be technicians, that each statistical problem which they may meet in after life will require its own formulation prior to any application of technique and will ordinarily be solved, insofar as it is solved, by an exercise of judgment rather than of technique. There is little excuse for not giving a sound theoretical background to statistics; the necessary mathematical technique is minimal. As is pointed out by Fréchet and Hallwachs in their excellent little book, "Probabilité à la Portée de Tous" (probability for everybody), arithmetic and algebra plus a willingness to think hard on knotty points are the requisites; the use of calculus though helpful fairly early can be postponed if unfamiliar to a late stage that is seldom reached in a first course in statistics.

We sometimes see in the press a pronouncement by Nicholas Murray Butler on politics, and again on prohibition. Presumably it was on one of these latter occasions that some scalawag of a compositor is said to have headlined him as Nicholas Murray, butler of Columbia University. What I fear many of us do not see or know are his equally strong trenchant dicta on education. His annual presidential reports are interesting reading and repay study. Let me quote a few detached sentences from the latest:

> Through ignorance the present-day banners of progress are everywhere emblazoned with the names of some of the oldest of humanity's discarded failures. . . . Nor is it in any wise true that all subjects of intellectual interest are of equal value and that the important thing is not what one studies but how he studies it. . . . Just now there is a strong tendency to exalt unduly certain recently devel-

[2] This type of course on the introduction to the calculus could be given in the first semester of the freshman year in forty-five exercises.

oped fields of knowledge which as yet consist almost entirely of futile talk and unproved opinion. . . . The longer one examines programs of study that are now most widely followed, observes the spirit in which school and college teaching is so often carried on, and notes the careful avoidance of anything that makes for genuine scholarship and power of reflective thinking, one is forced to raise the very far-reaching question, whether we have not destroyed the ideal of the liberally educated man and, with it, the liberally educated man himself.

I could quote more, but this is perhaps enough amply to cover what I said earlier about dwelling on the ideas of mathematics in general instruction and what I have just said about the lamentably low intellectual level of most of our courses and texts on statistics. I do not care to have any student making routine arithmetical calculations unless he is mentally equipped to understand the limitations of such methods and the conditions under which such calculations lead to legitimate inferences. Some training of fingers is a necessary accompaniment to the elevating of a brain, but the brain is the important thing for those who would be more than technicians.

Although too little mathematics keeps one from understanding statistics, too much is almost as bad. The mathematician who teaches this or any other applied science is very likely to err on the side of too much. It is a great mistake to think that because one finds his original material in the field of statistics or physics or engineering or physiology, subsequent mathematical analysis must be a contribution to that field—it may be just as pure mathematics as if it had originated as such. Much mathematical statistics has no significant statistical content. Many a memoir on mathematical physics is vacuous of physics. Once late in a course on mathematical physics Willard Gibbs came to set up and discuss the equations of motion of the top. In the course of the work he turned around to us, his face lighting up with a sweet smile, and remarked: There are some who seem to think that the top is chiefly interesting as furnishing exercises in elliptic functions. One branch of statistics where mathematics may easily run wild is in fitting frequency functions. Consider the tables printed in the adjacent column which give the frequency distribution of infant mortality rates for 1918 in I. Cities over 25,000, II. Rural Counties for white infants and III. Rural Counties for colored infants. The data are grouped for convenience. Clearly the rate might within the limits of its range have any value and although you can not have a continuous distribution of a finite number of elements you have here finite samples chosen from theoretical infinite universes and are confronted with the problem of fitting to these data some continuous curves which shall represent as well as may be the dis-

INFANT MORTALITY RATES IN 1918

I. CITIES OVER 25,000

Rate	Frequency
0– 19	0
20– 39	0
40– 59	1
60– 79	17
80– 99	43
100–119	40
120–139	27
140–159	13
160–179	1
180–199	2
200–219	0
220–239	0
	144

II. RURAL COUNTIES, WHITE

Rate	Frequency
0– 19	0
20– 39	9
40– 59	33
60– 79	63
80– 99	64
100–119	38
120–139	16
140–159	8
160–179	2
180–199	0
200–219	1
220–239	0
	234

III. RURAL COUNTIES, COLORED

Rate	Frequency
0– 19	1
20– 39	1
40– 59	5
60– 79	22
80– 99	19
100–119	42
120–139	37
140–159	30
160–179	19
180–199	17
200–219	10
220–239	12
240–259	8
260–279	4
280–299	2
300–319	1
320–339	0
340–359	0
360–379	1
380–399	0
400–419	1
420–439	0
440–459	1
460–479	1
	234

tributions of the hypothetical universes from which the samples are conceived as drawn.

Let us consider the application to our material of the system of analysis invented by Karl Pearson. The invention was one of great beauty; anybody could be proud of having such an idea. Frequency curves are of three main types: The U-shaped distributions with modes at the two ends, the J-shaped ones with a mode at one end and the skew and symmetric distributions with a mode between the two ends at both of which the distribution sinks to 0. Can frequency curves be reduced to a single system? Pearson's answer is that by and large they can be. His original memoirs should be read, but as an initiation one may more easily read chapter XV of D. C. Jones's "First Course in Statistics." The central idea comes to this: That the various types of curve satisfy the differential equation

$$\frac{dy}{dx} = \frac{y(x+b)}{px^2+qx+r}$$

of which the integrals depend on five parameters (one being a constant of integration) and the types depend on various relations between the four parameters other than the constant of integration. Moreover just as the differential equation $dy/dx = -xy/\sigma^2$ of the normal or Gaussian curve may be obtained from the binomial expansion $(p+q)^n$ so the Pearsonian equation is related to the more general hypergeometrical expansion. It is altogether a magnificent conception. The actual fitting of the frequency function of the appropriate type is made from the values of the first five moments which are:

(1) Zeroth moment. $\Sigma y = N =$ total number of observations.
(2) First moment. $\Sigma yx/N = M =$ the mean value of x.
(3) Second moment. $\Sigma yx^2/N = M^2 + \sigma^2$ gives the standard deviation.
(4) Third moment. $\Sigma y(x-M)^3/N = \sqrt{\beta_1}\,\sigma^3$, related to skewness.
(5) Fourth moment. $\Sigma y(x-M)^4/N = \beta_2\,\sigma^4$, related to kurtosis.

Rules for making the fit and tables to aid in the calculations have been worked out by Pearson. The whole represents a very large amount of work. It may also be stated without much fear of contradiction that even with all the tabular aid provided, fitting some of these types and checking the fit is considerable of a chore.

Is it all worth while? In many cases I am afraid it is not. Howsoever happy I should have been to invent the original conception and to discover how well it worked out, I think that for applications such as the above I should have regretfully abandoned the system as unsatisfactory—as too much mathematics. The three series of infant mortalities have been fitted—I give you the fits taken from the literature. (I do not guarantee them; moreover the scale and the origin are not those of the table, *i.e.*, as they stand they are *not* the equations of the frequency functions—but that is of no moment for the present discussion.)

$$\text{I. } y = 46.5502\left(1+\frac{x}{2.8946}\right)^{4.4296}\left(1-\frac{x}{14.5155}\right)^{22.2126}$$

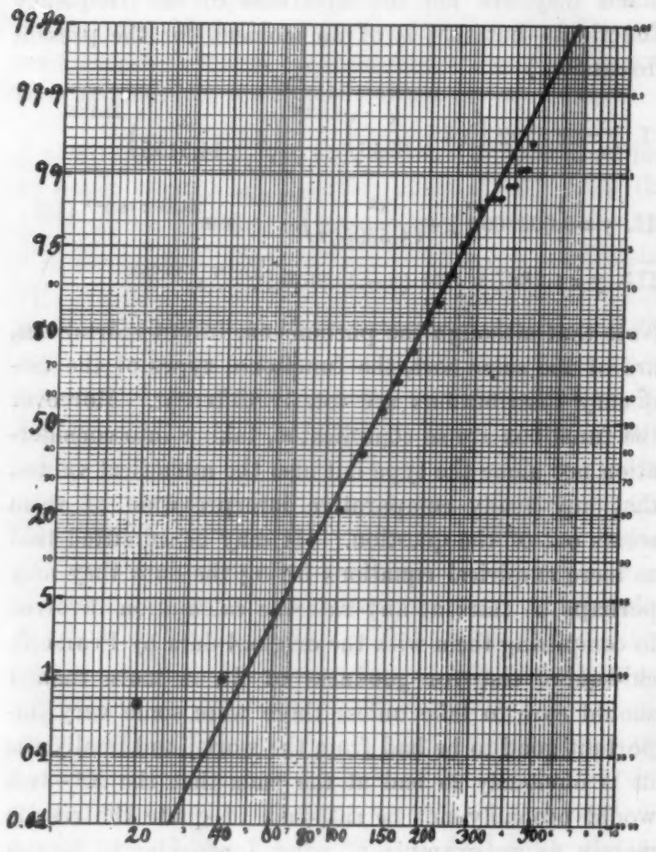
$$\text{II. } y = 0.005609\left(1+\frac{x^2}{(4.5095)^2}\right)^{-12.5407} \times e^{25.9862\tan^{-1}\frac{x}{4.5095}}$$

$$\text{III. } y = 4.2887\times 10^{27}\,(x-20.9629)^{3.0627}\,x^{-19.9804}$$

Note that although the phenomena, infant mortalities, are of the same sort, the functional types of the frequency distributions are totally different. Moreover the functions are so complicated, taking into consideration not alone the type but also the numerical values, that any ready comparative interpretation of them seems out of the question. (It may be admitted that as mere empirical equations fitting the data they may perhaps be fair; at any rate the calculation involved in comparing them with the original data by Pearson's chi-square test for goodness of fit, is more than I should care to take unless there were some very important good to be had from the work; and finally the fit is obviously so bad at the ends that the X^2-test would probably not be satisfied. I quote the results merely as an example of what I consider to be too much mathematics.)

You may ask how I should treat the data. It is a fair question. But I should have to retort with the question, what do you want to find out from the treatment? Much of our time may be saved from useless exercise of technique if we stop to ask what we are trying to find out and whether there is any expectation that we shall find it out by the application of any technique. But I will waive the question and set to work on the third set. First let us observe that infant mortalities under 20 are unlikely to be of statistical significance among the rural colored population; there are no such values in cities over 25,000 nor among rural whites, and I know of no reasonably large districts in the world where infant mortalities run under 20. Next at the other end of the distribution, mortalities above 400 may be open to suspicion, although there are places in the world, say in India or China, where such figures are not unknown, and maybe the same is true of some negro districts in America. However, we need not worry too much over a bad fit on the ends, and perhaps we shall be as well off anyhow as with equation III. As the distribution contains only positive values of the variable and is

skewed toward the origin, the first trial may be made graphically on logarithmic probability paper which has been made familiar to us by Hazen and Whipple.[3] It is seen that the summation curve on this paper is practically straight (Fig. 1). There is evidence that



we have too many cases of mortalities under 40 (only 2, to be sure) and over 400; this is in accordance with our suspicions but should not be regarded as confirmation of them. Unless we are in an old field of science with well established fundamental laws, it is not through mathematical developments but by critical analysis of the sources of the data that confirmation of suspicions may be had. The type of frequency function therefore appears to be

$$dy = \frac{234}{\sqrt{2\pi}\,\sigma}\, e^{[\log(x/x_0)]^2 : 2\sigma^2}\, d\log x,$$

where dy denotes the number of cases between two neighboring values of the logarithm of the infant mortality, x_0 is the geometric mean or the median of the values of x and σ is the dispersion or standard deviation of the values of log x.

The parameters of the curve may be determined graphically by methods that are well known and simple. For one such determination we have these figures.

The first 6 columns contain, respectively, the rate, the percentage less than that rate, the percentage in the immediate preceding interval of rate, the calculated frequency in that interval, the observed frequency and the differences between the observed and calculated values. The agreement is about all that could be desired. The last two columns give the calculation leading to X^2. The test is vitiated by the very low values of the theoretical frequency in the first single and last double interval; leaving these out we have 18 intervals with $X^2 = 14.3$. This represents a fit so good that chance fluctuations of sampling would produce a worse fit about twice out of three times. Such a correspondence between computed and observed values should be satisfactory and indicate that any more complicated curve such as III above is indeed entirely too much mathematics unless the fit is thereby much improved at the two extremes (as is not the case). The other tables of data can similarly be fitted adequately, I think, on logarithmic probability paper and spare us the annoyance of the complicated Pearsonian equations I and II.

FREQUENCY FUNCTION OF INFANT MORTALITY, 1918; RURAL COUNTIES, COLORED

Rate	% Less	% Diff.	Freq.	Obs.	Diff.	Diff.²	X^2
20	.00	.00001	0.00234	1	+ 1.0	1.0	(427)
40	.24	.24	.6	1	+ 0.4	.2	.3
60	3.0	2.76	6.4	5	− 1.4	2.0	.3
80	11.3	8.3	19.4	22	+ 2.6	6.8	.3
100	24.8	13.5	31.6	19	−12.6	158.8	5.0
120	39.7	14.9	34.9	42	+ 7.1	50.4	1.5
140	54.0	14.3	33.5	37	+ 3.5	12.2	.4
160	66.3	12.3	28.8	30	+ 1.2	1.4	.0
180	75.5	9.2	21.5	19	− 2.5	6.2	.3
200	82.6	7.1	18.8	17	+ 0.2	.0	.0
220	87.5	4.9	11.5	10	− 1.5	2.2	.2
240	91.3	3.8	9.0	12	+ 3.0	9.0	1.0
260	93.9	2.6	6.1	8	+ 1.9	3.6	.6
280	95.7	1.8	4.3	4	− 0.3	.1	.2
300	97.0	1.3	3.0	2	− 1.0	1.0	.3
340	98.5	1.5	3.5	1	− 2.5	6.2	1.8
380	99.27	.77	1.8	1	− 0.8	.6	.4
420	99.66	.39	.9	1	+ 0.1	.0	.0
460	99.80	.14	.3	1	+ 0.7	.5	1.7
500	99.89	.09	.2	1	+ 0.8	.6	(3.0)
		99.89	234.1	234			$X^2 = 14.3$

The X^2 test of goodness of fit is due to Pearson and a fine contribution to statistics it was. More recently R. A. Fisher has been over the work and appears to have made some improvements in it and to have given valuable discussions of its application; he also has gone forward with the treatment of the error of the correlation coefficient. Perhaps I may say at this point that, so far as I can judge, R. A. Fisher is to-day the intellectual leader of the biometric school. He is not merely applying the method by rote but is thinking about the problems of statistical analysis in his own right. In his "Statistical Methods for Research Workers" there are several excellent things new with him; the book, however, gives merely

[3] See G. C. Whipple, "Vital Statistics," 2nd Ed., p. 508.

the result; for the detailed reasoning one must consult Fisher's original papers. To Karl Pearson, the great contributor of many important advances in probability and statistics and builder of the science of biometry upon the foundation of Galton, his master, it must be a source of genuine satisfaction, as he nears three score years and ten, to see near at hand so able a disciple as Fisher, an Elisha, who as so often in the history of science, is embroidering, and maybe patching up a bit, the mantle of Elijah ere it falls upon him.

It is interesting to note that the methods of fitting by moments and of estimating goodness of fit by X^2 are logically inconsistent.[4] This may be seen most easily on the zeroth moment which is the total number N of the observations. Let F be the observed frequencies and y the fitted values and let us consider for convenience the actual fit in the intervals tabulated —a discontinuous problem instead of the continuous problems—graduation only instead of graduation plus interpolation.

$$X^2 = \Sigma \frac{(F-y)^2}{y} = \Sigma \frac{F^2}{y} - 2\Sigma F + \Sigma y = \Sigma \frac{F^2}{y} - N$$

if we take $\Sigma y = N$. Suppose however that after making this fit we adjust the values of y to new values Z by applying a factor c so that $Z = cy$ and $\Sigma Z = cN$.

$$X^2 = \Sigma \frac{F^2}{Z} - 2\Sigma F + \Sigma Z = \Sigma \frac{F^2}{cy} - 2N + cN$$

The minimum value of X^2_Z will not be given by $c = 1$ but, differentiating, by

$$-\left(\Sigma \frac{F^2}{y}\right)\frac{1}{c^2} + N = 0 \quad \text{or by} \quad c = \sqrt{\Sigma \frac{F^2}{Ny}} > 1$$

$$X^2 = N(c^2 - 1), \qquad X^2_Z = 2N(c-1)$$

The factor c and the change in X^2 are

$$c = \sqrt{1 + X^2/N}, \qquad X^2 - X^2_Z = N(c-1)^2$$

If X^2/N is well below 1, the results simplify to

$$c = 1 + X^2/2N, \qquad X^2 - X^2_Z = X^4/4N$$

and $\Sigma Z = cN$ becomes $N + X^2/2$. In the case above we should have a better fit by taking the total number of observations not as the actual number 234 but as $234 + 7 = 241$, but the improvement in X^2 would not be great. (However, the fit at the two extremes is so bad, small as are the actual numbers of cases, that X^2 if rigorously computed would obtain from the single observation in the 0–19 interval the value 427 which would make c about 1.7 and $X^2 - X^2_Z = 117$ or $X^2_Z = 327$, a great reduction, but still indicative of a very bad fit. Moreover, a change of N from 234 to about 400 is ridiculous, and although X^2 is thereby reduced the fit by any intuitive judgment is far worse.)

From such a simple consideration as this we obtain light on the significance of the X^2 test and yet more upon its limitations which are these: It is not a perfect abstract test but depends on the judgment of the person who uses it in respect both to the details of its arithmetic computation and to its interpretation as a criterion of goodness of fit; it is merely one factor, and a somewhat subjective factor, in aiding the investigator to make up his mind as to whether an attained fit is good enough or not. In the three cases of infant mortalities above mentioned my judgment based largely on graphical evidence and somewhat on a knowledge of the unreliability of the reported figures is that the simple solution I have given is as good as any reasonable person can ask, and this judgment is to my way of thinking not in the slightest called in question, but rather corroborated, by the application of the X^2 test. Many of the criteria of statistics are likewise of this loose character, they are not precisely mathematical truths as statistical criteria no matter how exact they may be as theorems in probability—and no other situation is useful or possible. For this reason I am not interested in a five-figure table of X^2, presumably two significant figures are all that are significant. It is so with many other matters and because it is I prefer that my students should not so much indulge by rote in elaborate but insignificant arithmetic as to form correct judgments by right of sound understanding. It is for this reason that I lament the low intellectual level of books and courses in statistics. It means too much of one kind of mathematics, too little of another kind.

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[4] Puristically speaking. A minimum problem determines its own criteria. Practically, if the fit is efficient (R. A. Fisher), the inconsistency is insignificant. If for simplicity I make so bold as to test the zeroth moment I should perhaps point out that ordinarily the number of observations N is not taken to be a disposable or fittable constant and that the theory of the X^2 test and the tabulated values of X^2 seem to depend somewhat on regarding N as given. Yet in some actuarial practices N is not preserved in the fitted graduation, it is not preserved by the ordinary least squares fit except when the type of fitted function y is of a restricted sort, and there seems to be no reason why a method of fitting appropriate to the theory of sampling might not be developed which should leave N disposable.

THE IMPORTANCE OF BIOLOGY FOR MANKIND[1]

PERMIT me to begin my short address by expressing my great joy to take part in such an important event

[1] Address delivered at the dedication of the new Charles Rebstock Biology Hall of Washington University, St. Louis, November 10, 1927.

for science as the dedication of Rebstock Biology Hall. This event seems to me to be an especially joyful one. I came to this country from Europe only a few weeks ago, where the interest in biological science is abating. The biological laboratories are not frequented in Europe, and one can not dream of founding there new biological institutions, where scientific work could be maintained in a proper manner. It is, therefore, especially joyful that the merits of biology are recognized in this country; and in St. Louis, the name of which has been recently so often repeated by the whole world, a new temple of science arises, devoted to the propagation of biological knowledge.

Biology, including as it does the study of both plants and animals, represents the only basis on which many sciences necessary for mankind are built. In order to avoid the transformation of medicine, agriculture and other applied sciences into quackery and primitive housekeeping their base must be made firm. All success of these sciences depends now only upon the further development of biology. And when their results do not satisfy us sometimes, the cause of this helplessness lies only in an insufficient or not quite correct development of biology. Let us, for instance, regard the cause of the well-known failure to successfully combat such an important and extended disease as cancer.

Our present medical treatment is mostly based on a cardinal principle of biology confirmed by Pasteur, that a spontaneous birth of living beings from dead material is impossible not only in reference to higher organisms but also to bacteria. As many diseases prove to be of a bacterial origin, one supposes usually that all diseases must be produced by microorganisms, though they could not be found in some important and even contagious diseases, as, for instance, in variola or smallpox and scarlet fever. Therefore sometimes cancer is supposed to be produced also by microorganisms. But on the other hand it could only be shown that bacteria can sometimes produce this disease, but it can also be brought about by other organisms and by some poisonous substances. As at the same time some observations have shown that cancer may be hereditary it is very probable that the cause of this disease lies in the organism itself. As is known, cancer consists in an uncommonly luxuriant growth of the epithelic tissue, of the skin, in such a luxuriant growth that the other tissues and even organs are deadened and destroyed thereby. It is evident that we shall only then understand the cause of cancer when we know the phenomena of growth. But what is growth? It is an elementary phenomenon of life, a necessary property of living matter filling those small parts of an organism which are called cells.

It may seem perhaps somewhat incomprehensible that on the occasion of the dedication of a new biological institution a botanist lectures on diseases. But elementary phenomena of life are appropriate to all living cells independently, whether they are plant or animal cells. At the same time only the study of these elementary phenomena of life will permit us to discover the cause of cancer.

I have chosen as an example the case of cancer, but not only this disease, but all the physiological and pathological phenomena of plants and animals depend upon the properties of the living contents of cells. All these processes are carried on in their contents, that is: in protoplasm and nucleus. Therefore in order to direct physiological and pathological processes we must know first of all the properties of protoplasm and nucleus, the properties of living matter.

This thesis has been recognized by a great number of physiologists and physicians, and we see towards the beginning of this century two new branches of biology arise, the so-called cytology and physiology of the cell, which have now hundreds of followers. One of these branches endeavors to study the form and shape of various formations which have been found in the cells of animals or plants. The other branch studies their physical and chemical structure, and physiological properties. Although both these sciences arose not more than 30 years ago, their discoveries are already very important, and it would be no great fault if we predicted that the future of biology will depend upon the progress of these sciences.

More than a hundred years ago chemistry experienced an analogical process of methodical transformation. Thanks to the introduction of quantitative analysis chemistry was able to study the molecules and the change of their structure. The chemistry of substances became the chemistry of molecules and the chemical reactions became quite clear; they proved to be only a consequence of the atomic structure of molecules. The success of the new ideas was so great already at the beginning of the nineteenth century that hundreds of organic and inorganic substances were artificially obtained, and among them such substances as have become so necessary for industry, medicine and agriculture.

Cells play such a part in biology as molecules in chemistry. The atoms are analogous to the formations and structures we find in cells. And since biology studies these formations and structures we could predict its further progress.

But living matter consists of chemical substances. And we see that cell physiology transforms itself by degrees into the chemistry and physics of cells. The

chemical composition of the principal substances of living matter is now established, and the following step of the chemistry of cells will be the artificial production of these substances.

The chemical and physical investigations of cells have explained to us the phenomena of diseases and death. The principal substances of living matter have proved to be so very inconstant as to be compared with explosive substances, which explode very easily, that is: they disintegrate into their component parts. They explode by a blow, by heat, by strong light, by the action of various chemical reagents, which react on their component parts. And accordingly the principal substances of living matter could be very easily destroyed by analogical agents: by a blow, by heat, by strong light, by the action of various chemical reagents, which react on their component parts. Therefore the study of explosive substances could help us to learn the properties of living matter. In order to combat against illnesses and diseases we must make the principal substances of living matter constant, so that they would not be so easily destroyed and would not lead living matter and organisms to death. But how can we make them constant? The study of explosive substances shows that the introduction of some chemically indifferent substances, for instance, narcotics, into liquid explosive substances, as for example into nitroglycerin, abolishes their explosive properties. It is sufficient to add only five per cent. of aceton to nitroglycerin to make it quite inexplosive. Accordingly, the introduction of like substances into living matter diminishes its sensibility to injurious influences. But whilst narcotic substances are really indifferent to explosive substances, they are not so in reference to the principal substances of living matter, because these substances contain proteins, which are destroyed by narcotics, and after a short excitement an injurious and dangerous effect is produced and makes living matter more sensible than before. But if we could find such a harmless narcotic substance which would not destroy proteins we could make our living matter constant and in this manner abolish illnesses and diseases. On the other hand, the study of the chemical composition of living matter in bacteria shows that this living matter differs from the living matter of animals and men. We can therefore expect that there are chemical substances which would destroy the principal substances of living matter in bacteria but would not destroy them in man. Therefore the time will certainly come when all harmful bacteria and the diseases produced by them will be expelled from earth forever, and it depends upon us to accelerate the coming of such a time. I am delighted to be able to predict it, and I hope that biology will be able to widen its ways, and to bring near this happy time. The foundation of this new institution proves to me that my hope is not in vain, and that this great country will help biology to display all its manifold powers. Therefore permit me to finish this speech by exclaiming: Long live biology!

W. W. LEPESCHKIN

SCIENTIFIC EVENTS

THE SOUTH AFRICAN STATION OF THE HARVARD OBSERVATORY

WITH the recent purchase of a permanent site on which the South African station of the Harvard Observatory will be erected, the work of erecting the plant has just begun, it is announced by Dr. Harlow Shapley, director of the Harvard Observatory. The site is on top of one of the "kopjes" located outside of the city of Mazelsport, which is fourteen miles from Bloemfontein, Orange Free State, South Africa. Building material, equipment and the instruments which will be used have been arriving in the city since July 1, 1927, when the astronomers first began activities there.

Until the new buildings are completed, the temporary station, which has been operated for some time, will continue to be used. Dr. J. S. Paraskevopoulos, who has been recently appointed assistant professor, and his wife are now in charge of the work of the temporary plant, and two of the four telescopes that are now in Mazelsport, with lenses of ten and eight inches, respectively, are in operation every night.

Cooperating with the Harvard authorities in the erection of the new station, the city of Mazelsport has constructed recently a new highway leading to the top of the hill on which the observatory will be located. When completed, the plant will include a group of buildings consisting of residences, office buildings, laboratories, work shops and garages.

When fully in operation the observatory will house more operating telescopes than any astronomical plant in the world. With three 60-inch telescopes, the observatory will be outclassed in the power of its equipment by only three institutions.

To secure a constant series of photographic plates of the various stars in the Milky Way will be the principal function of the observatory. Studies of these plates, Dr. Shapley states, will have considerable bearing on the knowledge of the size of the universe. The plates will be mailed to the observatory in Cambridge to be studied and filed away in their proper classification.

W. F. Waterfield, of the Cambridge Observatory staff, will leave within a few months to take charge of the final placing of the instruments. Dr. Shapley intends to visit Mazelsport in the future.

THE BATTELLE MEMORIAL INSTITUTE

ANNOUNCEMENT of the organization of the Battelle Memorial Institute at Columbus, Ohio, was recently made. The news edition of *Industrial and Engineering Chemistry* gives further particulars. Endowed with a large sum of money from the estate of John Gordon Battelle, his wife and his son, Gordon Battelle, the new institute at once assumes a strong position. A tract of about five acres, opposite the campus of the Ohio State University, has been secured and the construction of the first two buildings, costing about a half million dollars, will be undertaken in the spring. Gerald Wendt, now dean of the school of chemistry and physics at the Pennsylvania State College, has been selected as director, and the organization plans are now under way with the intention of beginning the operations of the institute by the fall of 1928.

The Battelle Memorial Institute has been organized as a corporation, not for profit, in order to perpetuate a trust arising from the joint wills of these three members of the Battelle family. A board of trustees was appointed in the will of Gordon Battelle, one member of which, ex-President Warren G. Harding, has since died. The present board of trustees consists of Joseph H. Frantz, of Columbus, Ohio; Bishop John W. Hamilton, of Washington, D. C., formerly president of the American University; Earl C. Derby, Harry M. Runkle and Gerald B. Fenton, of Columbus, Ohio, and J. Clare Miller, of Ashland, Ky.

Under the terms of the will the institute is to be located in Columbus. The tract now purchased lies on the banks of the Olentangy River and across King Avenue from the campus of the Ohio State University, with a frontage of 300 feet on King Avenue and extending about 1,000 feet southward toward Fifth Avenue. The administration building will face King Avenue and the laboratory buildings will extend southward on Tisdale Street.

While the main object of the institute will be industrial research under the fellowship system, very much as is now the practice at the Mellon Institute, the large income from the funds of the institute itself will be devoted to long-distance industrial research for the broad benefit of American industry and for scientific research. The will provided that any profit arising from the operation of the institute be devoted to charity or to the support of other scientific research.

After an extended inspection trip, in which the chief college and industrial research laboratories in the eastern portion of the United States were studied by the trustees and the director, Otto C. Daret, of Columbus, was designated as architect. The first building will stand as a memorial to the Battelle family and will comprise administrative offices, the library, a large auditorium, a museum, machine shop, stock rooms and a number of laboratory suites. The second building, which will be erected at the same time and will adjoin the administration building, will have individual laboratories on the third floor, but the remaining space, including the basement, first and second floors, will be an engineering shop.

A FUND FOR THE STUDY OF COLDS AT THE JOHNS HOPKINS UNIVERSITY

THE Chemical Foundation has made a gift of $195,000 to the school of hygiene and public health of the Johns Hopkins University for the study of "the origin, nature and possible cure of the common cold."

The fund is to be known as "The John J. Abel Fund for Research on the Common Cold" in honor of the professor of pharmacology of the Johns Hopkins School of Medicine, and will provide $25,000 in the first year, $35,000 in the second and $45,000 in the third, fourth and fifth years of the research work.

In his letter announcing the gift Francis P. Garvan, president of the Chemical Foundation, said:

> In asking that the name of your great scientist be connected with this research I am mindful not only of his preeminent position and services in science, but more particularly of his outstanding reputation as the man who, perhaps more than any other living scientist to-day, exemplifies the beneficial application of the science of chemistry to medical problems, which is my abiding interest in such researches as this.

Commenting upon the projected research, Dr. Abel said in part:

> The problem which has been set to our investigation by Mr. Garvan, of the Chemical Foundation, can only be studied by the cooperative efforts of the clinician, the epidemiologist, the bacteriologist, the pathologist, the pharmacologist, the biochemist and the physicist.
>
> Fortunately this spirit of cooperation prevails in the various institutes of the Johns Hopkins University and I am confident that the problem will be attacked with energy, unremitting industry and in a generous spirit of mutual helpfulness by the several investigators into whose hands it will be given.

The research work is to be administered by the following faculty committee: Dr. Lewis H. Weed, dean of the School of Medicine, *chairman;* Dr. William H. Howell, director of the School of Hygiene and Public Health; Dr. Warfield T. Longcope, professor of medicine; Dr. Carroll G. Bull, professor of immunology; Dr. W. H. Frost, professor of epidemiology; Dr. Samuel J. Crowe, professor of laryngology and otology; Dr. Lawrence H. Baker, executive secretary of the medical faculty.

THE NEW LIFE SCIENCES BUILDING AT THE UNIVERSITY OF CALIFORNIA

THIRTEEN departments will be housed by the new Life Sciences Building which is to be erected on the Berkeley campus of the University of California. Floor plans of the building, which is to be 450 by 230 feet, have been prepared and the regents have authorized Supervising Architect George W. Kelham to proceed with the working plans. Construction will start in the spring and the building, it is hoped, will be ready in 1929.

The building will house the following departments: Anatomy, bacteriology, biochemistry, pharmacology, physiology, hygiene, botany, psychology, household science, plant nutrition, zoology, museum of vertebrate zoology and board of health.

The following old wooden buildings will be torn down upon the completion of the new structure: entomology building, Budd hall, plant nutrition, museum of vertebrate zoology, physiology laboratory, hygiene and pathology, botany, botany laboratory, anatomy, psychology, zoology and the public health building.

The new Life Sciences Building, five stories in height, will provide each department with about 60 per cent. more room than it has at present, in all 145,000 square feet of floor space, approximately three acres. It will be in the shape of a hollow rectangle, with the laboratories facing the court inside. An auditorium with seating capacity of 500 will be located at the east end, balanced by the Museum of Vertebrate Zoology at the west end. The classrooms will be grouped at the east end, near the library, but the building itself will have a library of 90,000 volumes. There will be no elevators except those for freight service.

With the completion of the working drawings, plans and specifications, bids will be asked. It is expected the building will cost approximately $1,750,000, the funds to be taken from the $3,000,000 bond issue voted by the people in 1926.

A SYMPOSIUM AT THE ALFRED L. LOOMIS LABORATORY IN HONOR OF PROFESSOR J. FRANCK

THE arrival of Professor J. Franck in this country was made the occasion of a symposium in his honor at the Loomis Laboratory, Tuxedo Park, on January 6. About ninety physicists attended the symposium as the guests of Mr. Alfred L. Loomis. Opportunity was afforded for visiting the laboratory where the various investigations under way were described and illustrated.

The physical research institutions and university laboratories of the east were well represented, the following being among those present:

Dr. Lyman J. Briggs, Bureau of Standards.
Professor Karl T. Compton, Princeton University.
Dr. W. D. Coolidge, General Electric Company.
Professor Bergen Davis, Columbia University.
Dr. C. J. Davisson, Bell Telephone Laboratories.
Dr. Arthur L. Day, Geophysical Laboratory, Washington.
Professor William Duane, Harvard University.
Dr. Gano Dunn, National Research Council.
Professor R. C. Gibbs, Cornell University.
Professor Karl F. Herzfeld, The Johns Hopkins University.
Dr. C. W. Hewlett, General Electric Company.
Professor John C. Hubbard, The Johns Hopkins University.
Dr. Albert W. Hull, General Electric Company.
Professor Edwin Kemble, Harvard University.
Dr. Irving Langmuir, General Electric Company.
Professor F. Wheeler Loomis, New York University.
Professor J. C. McLennan, University of Toronto.
Dr. Howard McClenahan, The Franklin Institute.
Professor Louis W. McKeehan, Yale University.
Professor George B. Pegram, Columbia University.
Captain E. G. Oberlin, Naval Research Laboratory.
Dean Harold Pender, University of Pennsylvania.
Professor F. A. Saunders, Harvard University.
Professor W. F. G. Swann, Bartol Research Foundation.
Professor Oswald Veblen, Princeton University.
Professor H. W. Webb, Columbia University.
Dr. W. R. Whitney, General Electric Company.
Professor Albert P. Wills, Columbia University.
Professor Robert W. Wood, The Johns Hopkins University.

The following papers were presented:

The electrical and optical phenomena connected with the recombination of positive ions and electrons, by PROFESSOR J. FRANCK.

Some new effects in the optical excitation of mercury, by PROFESSOR ROBERT W. WOOD.

Concepts in quantum mechanics, by PROFESSOR W. F. G. SWANN.

Extreme ultra-violet spectra excited by controlled electron impacts, by PROFESSOR KARL T. COMPTON.

The aurora green line, by PROFESSOR G. CARIO.

SCIENTIFIC NOTES AND NEWS

FOR the meeting of the British Association for the Advancement of Science to be held next year in Glasgow from September 5 to 12, under the presidency of Sir William Bragg, the following sectional presidents have been appointed: Section A (mathematical and physical sciences), Professor A. W. Porter; section B (chemistry), Professor E. C. C. Baly; section C (geology), E. B. Bailey; section D (zoology), Professor W. Garstang; section E (geography), Professor J. L. Myres; section G (engineering), Sir William Ellis; section H (anthropology), Sir George Macdonald; section I (physiology), Professor C. Lovatt Evans;

section J (psychology), Professor T. H. Pear; section K (botany), Professor R. H. Yapp; section L (education), Professor A. Smithells; section M (agriculture), Dr. J. S. Gordon. The president of section F (economic science and statistics), has not yet been appointed.

ON February 16, Professor Hugo de Vries will celebrate the eightieth anniversary of his birth. On retiring from his professorship in the University of Amsterdam in 1918 he removed to the small village of Lunteren, Holland, and built for himself a laboratory and an experimental garden for the continuation of his genetical studies on Oenothera. He is still prosecuting these studies with a vigor and effectiveness which excites universal admiration. It is to be hoped that American biological organizations and institutions, biological departments in our universities and numerous personal friends and admirers of Professer de Vries will send appropriate messages to him on this occasion. Messages and resolutions timed to leave the Atlantic seaboard in the first days of February should reach him opportunely.

IN recognition of his thirty-five years as an outstanding teacher in the medical school of the University of Michigan and his international reputation as a pathologist, Dr. Aldred S. Warthin has been the recipient of an honor from his colleagues and former students, in the form of a volume entitled "Contributions to Medical Science." This book of 715 pages includes contributions from sixty-four authors, representing his early colleagues and including one or more representatives from each of his thirty-five successive classes.

THE board of directors of the Geographic Society of Chicago at its last meeting unanimously voted to award its gold medal to Colonel Charles A. Lindbergh. It is planned to present this medal to Colonel Lindbergh at the final meeting for the season in Orchestra Hall on April 24. Commander Richard E. Byrd, a gold medalist of the society, has been invited to come to Chicago to make the address of presentation.

JAMES A. PARSONS, metallurgist for the Dur Iron Company, has received the science award of the Harmon Foundation for his research in aluminum bronze, his discoveries on corrosion testing and his developments in duriron.

DR. WILLIAM RICE, dean of the Tufts College Dental School, will receive the 1928 award of the Rhode Island Dental Society at the semi-centennial convention of the society. The medal will be awarded "for his contribution to dental education, and his leadership and inspiration to the students under his guidance."

DR. HENRY CREW, professor of physics at Northwestern University, was elected president of the American Association of University Professors at its recent meeting in Cincinnati.

A. W. BERRESFORD, electrical engineer, was elected president of the American Engineering Council at the recent meeting held in Washington, D. C.

THE managers of the New York Botanical Garden have elected Henry W. De Forest, chairman of the executive committee of the Southern Pacific Company, president, to succeed Professor F. S. Lee, of Columbia University, who has been president for five years.

C. C. WILLOUGHBY, director of the Peabody Museum at Harvard University, has been made emeritus director. The position of director of the museum has been filled by the appointment of Dr. S. K. Lothrop, formerly research associate in the Museum of the American Indian, New York.

AT the fifty-ninth annual meeting of the trustees of the American Museum of Natural History on January 8, Dr. H. F. Osborn, president-elect of the American Association for the Advancement of Science, was elected president for the twentieth successive year; Mr. Baker, first vice-president, for the fifth year; J. P. Morgan, second vice-president, for the seventeenth year; Mr. Perkins, treasurer, for the second year, and Percy R. Pyne, secretary, for the eighth year. Dr. Osborn has accepted the post of curator-in-chief of the division of mineralogy, geology, geography and astronomy, and he has also accepted the honorary curatorship of the department of geology and paleontology. Dr. G. Clyde Fisher has been made curator of the department of astronomy. The new appointments are: Hawthorne Daniel, curator of the department of printing and publishing and editor of *Natural History;* Miss Francesca R. LaMonte, assistant in ichthyology, and Robert T. Hatt, assistant curator in mammalogy.

DR. ARTHUR PIERSON KELLEY, assistant professor of botany in Rutgers University, will go on February first to the Allegheny Forest Experiment Station, Philadelphia, as associate forest ecologist.

DR. DOUGLAS R. SEMMES, of Richmond, Va., has been appointed to the staff of the Alabama state geological survey.

MORSE SALISBURY, editor of the press bureau of the University of Wisconsin, has been appointed temporarily as chief of the radio service of the U. S. Department of Agriculture pending a new examination. The position has been vacant since the resignation of Sam Pickard to become secretary, and later a member, of the federal radio commission.

DR. B. T. DICKSON, formerly professor of plant pathology in McGill University, arrived in Sydney in November to take up his new duties as senior plant pathologist for the Australian Council for Scientific and Industrial Research.

PROFESSOR OSWALD VEBLEN, Henry B. Fine research professor of mathematics, has been granted a leave of absence for the coming academic year to carry on research work at the University of Oxford. Oxford will send to Princeton for the same period Professor Godfred H. Hardy, Savilian professor of geometry and a foreign member of the National Academy of Sciences.

DR. TAMOH IKEDA, in charge of food control for the bureau of public health of Tokyo, is spending the month of January working under the direction of Professor R. A. Dutcher in the vitamine laboratory of the Pennsylvania State College. Dr. Ikeda is visiting the United States under the auspices of the Rockefeller Foundation.

HARLAN H. ZODTNER, of the Smithsonian Institution, is leaving the United States to spend three years in the Chilean Andes, measuring the sun's radiation, as part of the institution's study of the solar constant. He will relieve H. B. Freeman, present director of the Smithsonian Observatory at Mount Montezuma, near Calama, Chile, who has completed three years in the region.

DR. OSCAR RIDDLE, of the Carnegie Institution, during the latter part of January will deliver a series of lectures at the University of Porto Rico on "Sex, Reproduction and Internal Secretions."

PROFESSOR JAMES FRANCK, of the University of Göttingen, upon his recent arrival in New York was entertained by the departments of physics and chemistry of New York University in the Brevoort Hotel. Dr. Franck delivered a series of lectures at Harvard University during the week of January 9.

DR. NIELS G. HÖRNER, of the Swedish Geological Survey, addressed the geological conference at Harvard University on January 17 on "European Inland Dunes and their Climatic Significance."

DR. HAROLD NORINDER, of the Swedish State Power Organization, will give a lecture at the Franklin Institute on January 26 on "Some Electrophysical Conditions determining Lightning Surges."

THE non-resident lecturer in chemistry at Cornell University under the George Fisher Baker foundation for the second term of the present university year will be Professor George Barger, of the University of Edinburgh, who will lecture upon "Some Applications of Organic Chemistry to Biology." The non-resident lecturer for the first term of the university year 1928–1929 will be Professor Hans Pringsheim, of the University of Berlin, who will lecture upon "The Chemistry of the Monosaccharides and Polysaccharides." The non-resident lecturers are provided with a private research laboratory, and the university extends the privilege of the department of chemistry to visiting chemists who may wish to carry on research under the direction of the lecturers.

DR. CARL F. CORI, from the State Institute for the Study of Malignant Diseases, Buffalo, N. Y., will deliver the third Harvey Society lecture at the New York Academy of Medicine, on Friday evening, January 27. His subject will be "The Influence of Hormones on the Fate of Carbohydrates in the Animal Body."

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution and retiring president of the Washington Academy of Sciences, gave an address before the 217th meeting of the academy, January 10, on "Prehistoric Ornithology in North America."

PROFESSOR S. R. DETWILER, of Columbia University, lectured to the biological section of the New York Academy of Sciences on January 9, on "Observations on the Growth of Nerves in the Embryo."

A STATUE of the late M. Emile Baudot, the inventor of the telegraph transmission instrument bearing his name, was recently unveiled in the courtyard of the French General Post Office in Paris.

THE Second Church building, now being used to temporarily house the department of zoology of Oberlin College, has been named the Albert A. Wright zoological laboratory, in commemoration of the services to the college of the late Professor A. A. Wright.

A MEETING to commemorate the life and services of the late Charles Doolittle Walcott, secretary of the Smithsonian Institution from 1907 to 1927, will be held in the auditorium of the natural history building on January 24, at 11:00 o'clock. The chancellor of the Smithsonian Institution, the Honorable William H. Taft, Chief Justice of the United States, will preside. Addresses will be delivered by the following representatives of organizations with which Secretary Walcott was actively affiliated: Dr. John C. Merriam, the Carnegie Institution of Washington; Dr. Joseph S. Ames, the National Advisory Committee for Aeronautics; Dr. George Otis Smith, the United States Geological Survey, and Dr. Charles G. Abbot, the National Academy of Sciences.

ALEXANDER E. OUTERBRIDGE, of the William Sellers Company, also lecturer at the University of Pennsylvania, and professor of metallurgy at the Franklin

Institute, died on January 15 at the age of seventy-seven years.

PROFESSOR ELMER E. F. CREIGHTON, electrical engineer of the General Electric Co., Schenectady, died on January 13, at the age of forty-nine years.

W. H. DINES, F.R.S., British meteorologist, well known for his explorations of the upper air, died on December 24, aged seventy-two years.

DR. W. C. F. NEWTON, research student at the John Innes Horticultural Institution, recently died at the age of thirty-two years. A correspondent writes: "The death of Dr. Newton is deplored by those interested in the development of cytology and genetics. His personality attracted the notice of William Bateson under whose sympathetic directorship he worked several years at the John Innes Horticultural Institution, Merton. He will be remembered for his beautiful study of the chromosomes of *Tulipa* and related genera, and for other work much of which is as yet unpublished."

A JOINT meeting of the Optical Society of America and The American Physical Society will be held at Columbia University in New York City on February 24 and 25. Special features will include an invited address by Dr. W. F. G. Swann on "Recent Theories of the Atom" and a demonstration of television at the Bell Laboratories.

THE annual congress on Medical Education and Medical Licensure and Hospitals will take place in Chicago at Palmer House on February 6, 7 and 8.

THE eighth summer term of the American School of Prehistoric Research will open in London on June 28 and close on the Continent the middle of September. Requests for information concerning details of the program and requirements for admission should be addressed to the director, Dr. George Grant MacCurdy, Peabody Museum, New Haven, Conn.

DR. WILLIAM CROCKER, Dr. Waldemar Lindgren and Dr. A. L. Barrows, of the National Research Council, recently conferred with members of the staff of the Biological Survey in the interest of arranging comprehensive cooperative studies of geological, zoological and botanical problems and other related lines of research, in the Aleutian Islands, Alaska. Effort is being made to enlist in this survey such agencies as the Biological Survey, the Bureau of Plant Industry, the Forest Service, the Geological Survey, the Coast and Geodetic Survey, the Bureau of Fisheries and the Smithsonian Institution.

A ROYAL commission to inquire into and report upon all matters relating to the fishing industry of the Maritime Provinces has been appointed and is holding sittings in all the important fishing centers of the Maritimes, so that those engaged in every branch of the industry will have opportunity to attend its sessions and discuss their problems. Subsequently, at the request of the provincial government of Quebec, which for the past few years has been administering the fisheries in all portions of the province, except in the Magdalen Islands, it was agreed that the scope of the investigation should be extended to the mainland of the Province of Quebec and sittings will be held there when the investigation is completed in the Maritimes.

THE council of the British Empire Cancer Campaign is sending invitations to persons and organizations conducting research into cancer to attend the International Convention on Cancer Research next July in London. Receipt of an anonymous gift of $50,000 to the campaign has been announced. The sum of $80,000 also has been set up as a permanent trust by the executors of the estate of William Johnston, of Liverpool. The interest will be applied to cancer research work in Liverpool.

AT a special general meeting of the British Institute of Physics held on December 16, and on the recommendation of the board, the Royal Meteorological Society was admitted a participating society of the institute. This is the sixth society to cooperate in the scheme of participation, and an important step is thus taken towards the realization of one of the principal objects of the institute, as expressed at its foundation, namely, to coordinate the work of all existing societies concerned with the science of physics and its applications.

A NEW meteorological observatory has been ordered by the government of India on the advice of its meteorological director, J. H. Field. It will be built at Poona for special research work, with a view to accurate forecasting of southwest monsoons and will be brought into use the coming summer. About $320,000 has been appropriated for the observatory.

A BEQUEST amounting to about £35,000 has been left by Mr. John Sanderson, manufacturer, of Galashiels, to Edinburgh University for the development of technical and scientific study under the faculty of science.

"THE Lasker Foundation for Medical Research" has been established at the University of Chicago with an initial endowment of $1,000,000, the gift of Albert D. Lasker and his wife, Mrs. Flora W. Lasker. Mr. Lasker is former chairman of the United States Shipping Board and head of the Lord and Thomas advertising agency. Research under the spirit of the endowment is to be directed toward establishing the causes, nature, prevention and cure of degenerative

diseases. While a definite program has not yet been developed under the foundation, it is said that the first efforts would be made against Bright's disease and heart disease.

ANNOUNCEMENT has been made by the University of Chicago board of trustees of the following subscriptions for the endowment of the Frank Billings Medical Clinic: From Mr. Samuel Insull, $25,000; Mrs. C. K. G. Billings, $10,000; Mr. Charles A. Monroe, $5,000; Miss Margaretta E. Otis, $5,000; Mr. John W. Fowler, $3,000; Mrs. Howard H. Spaulding, $3,000; Mr. John T. Llewellyn, $2,000; Mrs. Theodore Sheldon, $2,000; Mr. Walter S. Brewster, $1,000; Mr. William S. Hay, $1,000; Mr. George M. Reynolds, $1,000; Mr. George E. Scott, $1,000; Mr. and Mrs. William H. Rahmann, $600; Mr. Charles E. Field, $200; Mr. Thomas Meighan, $100, and Mr. R. H. Ritchie, $100. A total of $328,723 has already been received for the fund.

THE research ship *William Scoresby*, after being refitted, has left Portsmouth, England, on another cruise to the Antarctic. She returned from a similar expedition a few months ago. The first port of call will be St. Vincent, and the ship will then proceed by way of Rio de Janeiro and the Falkland Islands to the Antarctic. Commander De La Motte is in charge of the ship, and the trip is expected to last twelve months. The *William Scoresby*, which was built to work in conjunction with Shackleton's *Discovery*, is 180 feet long, of about 700 tons and is equipped with the latest scientific apparatus.

THE late Harry W. Loos has bequeathed a fund amounting to approximately $3,500,000 to Kansas City to be devoted to such charitable, hospital, educational, scientific, literary or research purposes as may be in the public interest.

UNIVERSITY AND EDUCATIONAL NOTES

GEORGE WASHINGTON UNIVERSITY announces receipt of the Isabella King endowment of $30,000 for the establishment of a fellowship or fellowships for special research in biology. The income from this endowment will be available in 1928–29.

DARTMOUTH COLLEGE has received a gift of $300,000 for a new fine arts building from Frank P. Carpenter.

THE National School of Medicine and Pharmacy, Port au Prince, Haiti, recently dedicated its new building. On the first floor are five classrooms, an assembly room, a dental department, a store room and an office for the dean. There are five laboratories on the second floor for the medical sciences. The Rockefeller Foundation made an appropriation of $30,000 for equipment and of another $30,000 for fellowships for men who are to be trained for positions on the faculty of the medical school. These fellowships have been awarded and the physicians are to study in Paris, Strasbourg, Ann Arbor, Boston, New Haven, Chicago, then return to Haiti to become members of the faculty.

AN offer by the joint committee of the Paviors' Company and of the Institution of Municipal and County Engineers to establish a part-time chair of highway engineering in the University of London for post-graduate students has been accepted.

DR. FRANK J. GOODNOW, president of the Johns Hopkins University, has offered his resignation to the board of trustees, to be effective not later than July 1, 1929.

DR. WILMER KRUSEN, director of the department of health and recently elected president of the Philadelphia College of Pharmacy and Science, formally assumed his new duties as president of the school on January 3.

DR. JOSEPH S. CHAMBERLAIN, professor of organic and agricultural chemistry, has been appointed head of the department of chemistry of the Massachusetts Agricultural College. Dr. J. B. Lindsey, formerly head of the department, resigned from this position and is continuing his work as head of the department of plant and animal chemistry of the experiment station, in which work he has been engaged for the past thirty-seven years.

DR. FRANK B. MALLORY, pathologist of the Boston City Hospital, has been appointed professor of pathology at the Harvard Medical School.

DR. E. DAVID FRIEDMAN has been appointed professor of neurology and head of the department at the University and Bellevue Hospital Medical College.

DISCUSSION AND CORRESPONDENCE

THE PROPOSED TRANSFER OF GEODETIC WORK OF THE U. S. COAST AND GEODETIC SURVEY

IN connection with House Resolution 7480, introduced in the House of Representatives by Mr. Sinnott on December 15, 1927, my attention has been called to a circular letter containing unfavorable comments upon this measure, and several scientists interested in our work have written me requesting more specific information. These comments state that the proposed transfer could be justified only on one or more of three suppositions:

First: "That the Coast and Geodetic Survey is not doing the work properly." There is no basis for this supposition. Foreign geodesists allude to the Coast and Geodetic Survey as the foremost geodetic institution in the world, and I concur most heartily in this opinion.

Second: "That the Geological Survey can do the work better." Of course the Geological Survey can not do it better, for we all believe that the work of the Coast Survey is of the very highest quality, but I do believe that the Geological Survey can do it just as well if we can continue to have the cordial cooperation that we have received from the Coast and Geodetic Survey in the past. The circular letter states that the Geological Survey has never done any first order triangulation and traverse and has done no first order leveling for many years. This statement is unfortunate. The facts are that we have done first order triangulation and leveling, but have not done any in recent years because we have felt that it would be a duplication of effort, inasmuch as the Coast Survey was already engaged on similar work. Until recent years the Coast Survey planned a great deal of its first order work to meet our mapping needs, but since the world war it has confined its activities very largely to the program of covering the entire country with these first order arcs or circuits without much attention to the mapping program, except as we have transferred money for specific jobs. Up to recently I think this program has been a wise one, but the adjustment of the western arc of triangulation and a large part of the basic level network have been made and my associates feel that a large part of the first order control work to be executed in the future should be planned to meet the immediate needs of the topographic mapping program.

Third: "That a better theoretical organization can be secured by the transfer." The circular letter states that the Coast and Geodetic Survey is the only purely surveying bureau in the government, while the Geological Survey primarily is concerned with geological investigations. An analysis of our topographic mapping operations during the past seven years will show that only a small percentage of the topographic work has been executed to meet the immediate needs of our geologic program, but that our topographic mapping has been planned rather to meet the general engineering and scientific needs of the country. The circular states that the interior geodetic work has been planned to meet the requirements of the Geological Survey. This is not an entirely correct statement, but if it is true that the primary reason for conducting the interior geodetic work is to provide adequate control for topographic mapping, I am confident that it can be coordinated and performed more expeditiously and economically if it can be administered by the same organization that is charged with the topographic mapping.

I have been informed that the real reason for the circulation of the unfavorable comments is that a number of scientists are concerned with the effect of the proposed transfer upon the results now being secured in the study of earth movements in California, through the cooperation now existing between the Coast and Geodetic Survey and the scientific organizations interested in seismology in California. If the authorization and appropriation for precise triangulation and leveling and seismological observations in regions subject to earthquakes were transferred to the Geological Survey, we should hope to continue to cooperate just as the Coast Survey is now doing. In fact, during the next two years of the program we would probably arrange to have the work continued by personnel detailed from the Coast Survey, as is provided in the bill.

The bill was initiated by the Secretary of Commerce, who several years ago had stated that he would transfer the geodetic work of the Coast Survey to the Geological Survey as soon as he had authority by law. At the hearings before the joint committee on reorganization of the executive departments, both the Secretary of Commerce and the Secretary of the Interior indorsed this proposed transfer.

The present bill was drafted jointly by the two departments and was transmitted to congress with a letter of indorsement signed by the two secretaries. This letter brought out the fact that the primary function of the Coast and Geodetic Survey is to produce nautical charts, while one of the primary functions of the Geological Survey is to produce the standard topographic map of the United States. Geodetic surveys for the control of our coast lines were started by the Coast Survey in the early days of that organization, and later when the need for similar control in the interior of the country was manifest, the Coast Survey extended its geodetic work into the interior. Geodetic control is essential for topographic mapping, and the principal purpose of the geodetic work of the Coast Survey in the interior has been to furnish the control needed by the Geological Survey for its mapping activities. The letter stated that this divided responsibility for the production of the topographic map is fundamentally unsound, and that one agency should be charged with every step in the project.

The proposed bill meets with my hearty approval for the following reasons: The topographic work of the Geological Survey has been planned with the fundamental idea of making as much progress as possible toward the ultimate completion of the mapping program. The interior geodetic work of the Coast Sur-

vey has been largely confined to the extension of control to cover the entire country with large arcs or circuits of precise work. Much of this work is being extended over areas already topographically mapped, and such work as the Coast Survey has done in recent years for immediate use in mapping has been actually paid for by transfer of funds from the Geological Survey. While much duplication of effort of the two bureaus has been eliminated through the cordial cooperation that exists, still there is considerable divergence of policies and plans and there is not that degree of coordination which must exist in order that a comprehensive program may be prepared and executed in the most effective way.

Publication of geographic positions and spirit level elevations should be standardized in one organization. The geodetic work should be planned to meet the immediate needs of the mapping program, and often the same geodetic field party should do the precise work and follow immediately with the secondary control now executed by the Geological Survey. A substantial saving of overhead expense in field and office operation and in the procurement and use of equipment would be effected if the transfer were made.

GEO. OTIS SMITH,
Director

UNSTABILITY AT THE ABSOLUTE ZERO OF TEMPERATURE

IT has been shown by the writer (*J. Phy. Chem.*, 31, 747–756 (1927)) that a substance or mixture in the condensed state under its vapor pressure at the absolute zero of temperature T has zero controllable internal energy and entropy. With this as basis the writer has calculated the internal energies of a large number of the elements, which are given in a paper just published (*J. Phy. Chem.*, 31, 1669–1673, 1927). The largest and smallest values obtained were 1,535 and 1,037 cal./mol. for lead and iron respectively. Since G. N. Lewis has already calculated the entropies of these elements, it was possible to calculate also their free energies, the largest and smallest values being $-2{,}791$ and -750 for lead and chromium respectively.

An interesting point presented itself in these investigations. If a substance is lowered in temperature to the absolute zero it may not finally be in a condensed and vaporous phase at zero pressure. A further change at $T = 0$ will therefore have to take place before its internal energy is zero. Now it has also been shown by the writer (*J. Phy. Chem.*, 31, 940, (1927)) that the adiabatic of zero entropy corresponds to $T = 0$. It follows from this that a change in internal energy at $T = 0$ appears as external work. Hence under these conditions a substance will become unstabled at $T = 0$ and exert a pressure. On allowing the substance to expand doing external work it will finally end in the condensed state under zero vapor pressure, when its internal energy is zero. It was shown in the paper mentioned that white tin should behave in this manner at $T = 0$, and develop while expanding to become stable an average pressure of about 3,000 atmos. Thus certain substances may act like an explosive at or near the absolute zero of temperature.

This result has an interesting astronomical aspect. Dark bodies in interstellar space which are losing more heat than they receive eventually sink in temperature to near the absolute zero, and then may possibly get unstable and explode. This may conceivably happen to our moon some day if it radiates more heat than it receives, and has compounds in its composition possessing this property.

R. D. KLEEMAN

SCHENECTADY, N. Y.

THE THEORY OF "VISIBLE RADIATION FROM AN EXCITED NERVE FIBER"

IN a recent article in SCIENCE,[1] Mrs. Christine Ladd-Franklin gave an exposition of the phenomenon of the reddish-blue arcs and of her interpretation in terms of visible radiation from the excited nerve fiber. A foot-note in this article gives a reference to a paper of mine, and in the same foot-note Mrs. Ladd-Franklin describes an observation of her own and gives her interpretation. To the casual reader it might easily appear that the observation and opinion are quoted from my article. To avoid any such misinterpretation I wish to go on record as disagreeing absolutely with Mrs. Ladd-Franklin's interpretation of the reddish-blue arcs and the other phenomena which she cites. I do not believe that the evidence compels us to assume visible radiation from excited nerve fibers. The explanation set forth by Amberson[2] and others, based on secondary excitation by the action currents of the nerve fibers, seems quite adequate and requires less violent efforts of the imagination.

Mrs. Ladd-Franklin's point concerning the "place coefficient" of the sensation is sound, and we must agree that the secondary excitation is in rod, cone, bipolar cell or ganglia—not in the nerve fiber; but her argument against electrical excitation of one of these elements is unconvincing. Electric stimuli applied to the eye externally may give the sensation of light without a residual image, and this we may

[1] Christine Ladd-Franklin, 1927. SCIENCE, lxvi, 239.

[2] Amberson, W. R., 1924. *Am. Journ. Physiol.*, lxix, 354.

interpret as direct excitation of nerve fibers. This does not prove that an electrical disturbance *localized in the retina,* like a nerve action current, might not stimulate the photosensory mechanism directly.

It is worth noting that the phenomena reported by Nodon[3] of photographic effects from organic substances, which he interprets as due to "radiations" and which Mrs. Ladd-Franklin cites in support of her theory, have long been familiar. The subject has been reviewed by Keenan[4] and the weight of evidence points to the evolution of traces of hydrogen peroxide as the explanation.

HALLOWELL DAVIS
HARVARD MEDICAL SCHOOL

THE ANTIQUITY OF THE DEPOSITS IN JACOBS CAVERN

NELS C. NELSON in SCIENCE, for September 16, 1927, criticizes the article by me on "The Antiquity of the Deposits in Jacobs Cavern," printed in *Am. Mus. Nat. Hist.,* Vol. XIX, Part VI.

Admittedly *not* found in undisturbed strata, the Jacobs Cavern carved "Mastodon" bone must stand or fall upon its own merits. X-ray photographs and specific gravity determinations show this bone to be mineralized; inspection shows that mineralization occurred *after* the carving. Comparative photographs under six definite wave-lengths of light indicate that the bone is old and likewise the carving. Chemical and physical analyses (by experts in these fields) of samples taken in the presence of Mr. Nelson (and their position recorded photographically) show the presence of a second, lower, inhabited layer not examined by Mr. Nelson. The perforation of the carved bone was from both sides; these two holes taper and meet at a slight angle—the shortness and taper of these holes are characteristic of stone drills. The head of the elk-like effigy on the reverse apparently takes advantage of a crack, while the wavy marks on the same side ignore several cracks.

Against these definite data stands the sincere guess of an eminent archeologist.

VERNON C. ALLISON

THE MISPRONUNCIATION OF "DATA"

APROPOS of the controversy concerning the singular and plural usage of "data," may attention be called to the fact that this word is mispronounced much more commonly and with less justification than it is incorrectly used in writings. Probably no other word in the vocabulary of the average scientist is mispronounced more generally. Merely as an example of this fact, the incident mentioned below is noted from the last annual meeting of the Pacific Division of the American Association for the Advancement of Science. The pronunciations "dāta" and "dăta" were used by two different persons on the program at one of the general meetings. In a meeting of the section on entomology one speaker pronounced the word "dāta" another pronounced it "dăta" and a third said "dăta." The leading dictionaries including Funk & Wagnall's New Standard and Webster's New International give only one pronunciation, namely, dāta.

In some respects this matter may seem too trivial to be mentioned. However, the student in high school, college and university, and Mr. Average Citizen have come to regard the scientist as one who is peculiarly exact and correct, and this ideal is not enhanced when scientists, in classroom instruction and in public addresses, are careless to the extent of mispronouncing a word that is used so commonly by scientists in general.

R. H. SMITH
UNIVERSITY OF CALIFORNIA

[3] Nodon, A., 1924. *Comptes Rendus,* clxxviii, 1101.
[4] Keenan, G. L., 1926. *Chemical Reviews,* iii, 95.

SCIENTIFIC BOOKS

Les problèmes de la physiologie normale et pathologique de l'os. R. Leriche et A. Policard. Masson et Cie, Paris, 1927.

THIS book of 229 pages, including 23 text figures and an extensive bibliography of 219 titles, is dedicated to the memory of Leopold Ollier, "originator of modern bone physiology." The book represents the fruit of a collaboration extending over a period of ten years. It assembles in a convenient and logical unit much of what had been scattered under separate and joint authorship through various journals since 1909. A new theory of osteogenesis is here developed and firmly based on a large body of data, histological, experimental and radiographic. This theory furnishes a consistent interpretative key for the explanation of certain apparently contradictory facts in normal bone development and regeneration. It explains, moreover, diverse and obscure pathologic condition of bone formation. It reconciles the paradoxical aspects of the current view of osteogenesis which regards the so-called osteoblast, when operating alone, as a bone builder, and when fused in masses, as a bone destroyer or osteoclast.

Osteogenesis is interpreted in essence as a condition of osseous metaplasia of fibrous connective tissue. This is shown to occur in four stages, whether the connective tissue be embryonal, or mature fibrous: a, edematous infiltration; b, multiplication of fibrils; c, conversion of the interstitial fluid into a gelatinous

preosseous substance; d, deposition of calcium phosphates and carbonates. These processes are dependent upon humoral and interstitial rather than upon cellular factors.

Osteoblasts are regarded as fibroblasts with only a feeble osteolytic capacity. Their function is to oppose and restrict osseous extension. Cases are cited in which new formation of bone, as disclosed by skiagraph, is unaccompanied by osteoblasts. Conversely, osseous areas in which there is no new formation of bone are covered with osteoblasts of typical epithelioid character. Osteoblasts become secondarily involved in osteogenesis and thus are incorporated as osteocytes. As such they have no osteogenic nor nutrient functions; they are "useless parasites of osseous tissue." However, under the influence of certain pathologic factors they may have their original osteolytic capacity greatly stimulated. Osteolysis also is primarily dependent upon humoral processes. Osteoclasia, by action of osteoclasts, is said to be a relatively minor factor in bone resorption.

The results of experiments with rabbits, involving resections, fractures and transplants, are in accord with the earlier ideas of Havers, Bichat, and Macewen, who regarded the periosteum simply as a structure limiting ossification. The periosteum "blocks osteogenesis." The so-called osteogenetic layer of the periosteum is not a bone-forming tissue; it opposes and restricts the spread of bone. New formation of bone is invariably associated with bone resorption. The formation of callus in the repair of fractures is preceded by resorption of the broken extremities of the bone. Likewise, in the case of bone transplants; the transplant is resorbed before new bone appears. Such resorption supplies the necessary local excess of calcium for the stimulation of the osseous metaplasia. Osseous metaplasia of connective tissue is a reversible process. Bone resorption follows upon increased circulatory activity locally, a condition dependent upon vasomotor control. The authors believe that the results of their investigations open a new chapter in bone pathology, that of bone diseases of vasomotor origin.

H. E. JORDAN

UNIVERSITY OF VIRGINIA

SCIENTIFIC APPARATUS AND LABORATORY METHODS

METHODS FOR DETERMINING THE COLOR OF OBJECTS IN MICROSCOPIC MOUNTS

MICROSCOPISTS who have attempted to determine the color of minute objects in microscopic mounts, such as fungous spores, have felt the need of improved methods.

The method commonly employed for this operation is to observe the object through the microscope, form a mental color image and match this, as soon as possible, with a color on a color chart. However, the color chart is sometimes omitted and an opinion rendered. The results obtained by these methods have been uncertain since an accurate mental color impression of sufficient duration and intensity could not be retained until the observer had made proper comparisons with the standard colors, or his memory of color standards was inaccurate. These difficulties might be overcome if the microscopic object could be projected on a color chart or images of the microscopic object and the color chart observed simultaneously.

Krieger[1] has described a method for determining the color of spore prints made from *Volvaria speciosa Fr.* as a type. However, a good method for determining the colors of spore mounts by microscopic examination remained to be described. The writers have devised methods by which the object in a microscopic mount may be projected and observed simultaneously with those on a chart of standard colors.

In the first method employed by the writers, the apparatus consisted of a microscope equipped with Abbé condenser, camera lucida with drawing board, two table lamps each bearing a 75-watt daylight ground glass bulb, a Ridgway color chart, and a comparing screen which consists of a sheet of gray paper about 8 x 10 inches with a slit 1 x 0.75 inches cut in the center. The color standards were lighted by one of the lamps and the microscope by the other. By properly adjusting the Abbé condenser, the two lamps and the camera lucida, an image of the colored microscopic object was superimposed on the comparing screen beside the slit. While the comparing screen was held stationary, the color standards were moved so that an analogous color showed through the slit. The color standards were further adjusted and proper comparisons made until the slit contained a standard color which matched favorably with that of the microscopic object. By this method, the observer can compare the colors as accurately as his ability will permit. When one type of microscope was used, the microscope was placed on a plane about three inches above the level of the drawing board but when another type was employed, the best results were obtained when this distance was increased to five inches. How-

[1] Krieger, L. C. C. "Observations on the Use of Ridgway's New Color Book. The Color of the Spores of *Volvaria speciosa Fr.*" *Mycologia* 6: No. 1: 29–31. 1914.

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ever, the microscope and drawing board may be placed on the same level. The methods of lighting the microscope and chart may also be varied from those already described. Good lighting was obtained with three forty-watt lights; one for lighting the microscope and two for the color chart. When sunlight was employed, it seemed preferable to place the color chart in the bright sunlight, for a short time, and the microscope in a shadow.

In the second method, the apparatus commonly used for making photomicrographs was employed. Working in a darkroom, an image of the microscopic mount was focused on the ground glass of the camera in the usual way. The ground glass was then removed and placed about eight inches back from its natural position and the object refocused. The color standards with the comparing screen were then substituted for the ground glass. The color of the microscopic mount as projected could then be compared with the colors on the color chart by employing methods already described. However, the camera may be removed and an image of the microscopic mount projected on a horizontal surface by aid of a mirror commonly attached to the apparatus for this purpose.

The third method was devised as a laboratory aid in classifying fleshy fungi. Students experienced considerable difficulty in determining the colors of basidiospores, especially those of ochre, brown and rose colors. An eyepiece color comparator was constructed by flowing a negative varnish over a cover glass which could be placed in the tube of an eyepiece to a microscope. Before the varnish had hardened, four narrow parallel bars of transparent water colors were painted across the center. Deep yellow, geranium pink, mahogany brown of the Japanese transparent water colors were employed while India ink supplied the black. The color was more dense on one end of the bar thus giving a comparison of the diluted with the concentrated color. By placing this eyepiece color comparator in the eyepiece of the microscope, its colors and those of the microscopic object could be observed simultaneously and the relative colors of basidiospores determined. The colors on the eyepiece color comparator were standardized by the camera lucida as previously described. Thicker glass for the color comparator was obtained by choosing a microscopic slide of clear, thin white glass and a disc of the desired diameter was cut with shears under water. It seemed inadvisable to place the colors on a microscopic slide or its cover glass.

Finally, the methods described in this article may be successfully employed by one familiar with the use of a camera lucida. Furthermore, the proper lighting of the microscope, photographic apparatus and the color chart insures success when determining the color of microscopic objects by these methods.

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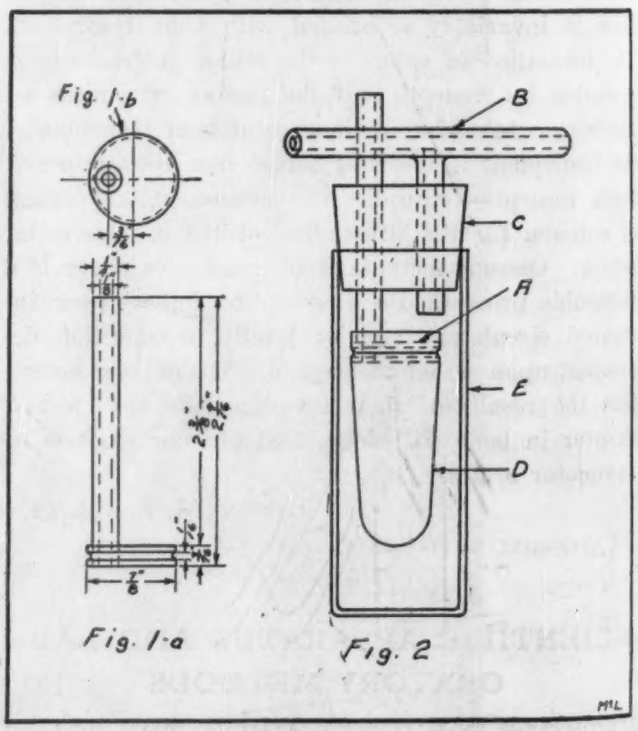
A MODIFIED ERLANGER SPHYGMOMANOMETER

ABOUT a year ago, when the writer attempted to assemble an Erlanger type recording sphygmomanometer, he was confronted by the impossibility of securing the special rubber bulb used in such apparatus. In casting about for a suitable one, many types of rubber bulbs and finger cots were tried without success until one day, after the cuff had been used for arm plethysmographic apparatus, the cast-off fingers of a rubber glove were tried. The finger of the glove was tied over a disc placed inside a capsule constructed as described (Figures 1 and 2) and served so satisfactorily that the writer thought others might find the apparatus useful.

The center of a ⅞-inch round brass rod was located and a ¼-inch hole was centered and drilled 3/16 inch from the center of the rod. With a lathe a 3/32-inch groove was cut around the circumference of the rod and a 3/16-inch disc cut off. A piece of ¼-inch brass tubing about 2½ inches long was soldered in the hole in the disc. The side and bottom views, respectively, of this disc are shown in figures 1a and 1b.



When assembling (see figure 2), the finger of the glove D is slipped over the disc A and tightly tied by means of strong waxed linen thread. The brass tube B is forced through one of the holes in a number 7 rubber stopper C. One arm of the T-tube B is pressed

through the other hole in the rubber stopper, and the stopper tightly inserted into a 34 x 90 millimeter homeopathic vial E. By means of a band of thin sheet brass 1½ inch wide the vial, in the inverted position, may be neatly mounted upon a 4 x 4 inch piece of oak board, which will also support the pressure gauge of the sphygmomanometer. The board in turn is supported by a ring stand.

In assembling the completed apparatus the tube leading to the glove finger is connected with the sphygmomanometer pressure system; one tube of the brass T is connected to a compound lever tambour and the other, when provided with a short length of rubber tubing and a pinch cock, serves to control the pressure in the recording system.

The rubber finger was obtained from a Paragold rubber glove, SR702, made by the Seamless Rubber Company, New Haven, Conn. The homeopathic vial is larger than is now regularly catalogued but may be obtained upon special order. Since it is used here as regular equipment, we put it to a variety of uses. It is possible that a smaller disc may be made and a 25 x 70 millimeter vial used.

A. R. McLAUGHLIN

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SPECIAL ARTICLES

ZEOLITE BEDS IN THE GREEN RIVER FORMATION[1]

AT several horizons in the upper half of the Green River formation of Utah and Colorado, an extensive series of Eocene lake beds that contain large deposits of oil shale, there are thin more or less persistent beds resembling sandstone that consist almost wholly of perfect or euhedral crystals of the zeolite mineral, analcite. These crystals differ greatly in size and reach a maximum diameter of nearly 2 millimeters. All are clouded with dust-like inclusions that make them dull gray and opaque. The character of the matrix as well as the proportion of matrix to zeolites differs from bed to bed. Both these factors are significant. In general those beds with relatively few zeolites have a distinctly tuffaceous matrix consisting of silica in the form of the mineral chalcedony in which are embedded many angular fragments and elongate splinters of feldspar and quartz together with laths of biotite and euhedral crystals of orthoclase, apatite and zircon. More rarely they contain good crystals of plagioclase and either hornblende or pyroxene. Clay minerals and carbonates which make up the associated beds are virtually absent. Other zeolite beds contain a very subordinate amount of chalcedonic matrix and if transitional beds between these and the distinctly tuffaceous type had not been found their relation to volcanic ash would have been utterly obscure. In addition to the analcite most of these beds contain a few small crystals of another zeolite mineral, apophyllite. Even some of the analcite crystals contain perfect though minute crystals of apophyllite.

In the summer of 1925 the writer found zeolite beds at one or more horizons at the following localities in Utah: about 700 feet above the base of the Green River formation in the canyon of White River, sec. 27, T. 9 S., R. 25 E., Uintah County and at approximately the same horizon in Hells Hole Canyon, sec. 22, T. 10 S., R. 25 E., also in Uintah County. One of these beds is lenticular and in places exceeds three feet in thickness. In Colorado similar beds were found at several places along White River in the western part of Rio Blanco County and in sec. 26, T. 3 S., R. 99 W., Garfield County.

Besides these crystal beds analcite occurs plentifully also disseminated in many oil shale beds of the Green River formation in Wyoming as well as in Utah and Colorado. Small apophyllite crystals too are scattered through these beds and, like the analcite, the greater number of them are euhedral. Some oil shale strata contain more than 16 per cent. by weight of analcite and others contain 1 or 2 per cent. of apophyllite. In the oil shale the zeolites are associated with numerous euhedral orthoclase crystals, angular quartz fragments and a little volcanic glass in addition to the calcium and magnesium carbonates and clay minerals that are principal constituents of most of the oil shale in this formation.

Field and microscopic study of these two types of zeolite-bearing rock indicates that both minerals formed in place on the lake bottom (or when only shallowly buried in ooze) as a result of interactions between various salts dissolved in the lake water and the dissolution products of volcanic ash that fell into the ancient Green River lakes. Presumably the volcanic material which makes up a really considerable part of the Green River formation came from Eocene volcanoes that were active in or near the San Juan Mountains in Colorado about 200 miles to the southeast.

This almost complete zeolitization of tuffs adds another interesting phase to the broader problem of the alteration of volcanic ash. Its relation to the origin of bentonite, however, is unknown for, so far as the writer is aware, the Green River formation

[1] Published by permission of the director of the U. S. Geological Survey.

contains no bentonite. On the other hand, it contains at least one bed of fairly fresh crystal tuff whose composition is approximately that of the igneous rock andesite. It is altogether likely that careful tracing of these tuffs and zeolite beds will demonstrate that they have an enormous lateral extent, comparable perhaps to bentonite beds. If so they would be of considerable value as precise correlative units.

As these zeolites must have formed at a temperature approximating the mean annual temperature at the earth's surface their occurrence suggests the possibility that the zeolite gels of soils may, under favorable conditions, crystallize into definite minerals. Indeed there appears to be a significant analogy between the occurrence of a natural sodium aluminum silicate gel recently described by Burgess and McGeorge[2] from the alkali soils of Arizona and this occurrence of analcite, a crystalline form of sodium aluminum silicate, in the beds of an ancient alkaline lake. Hence it seems within reason to expect that certain fossil or perhaps even recent alkali soils might contain definitely crystallized zeolites.

A more complete account of these zeolite beds together with the data which led the writer to the conclusions expressed here will be presented later in a report by the U. S. Geological Survey treating the mineralogy of the Green River formation.

W. H. BRADLEY

U. S. GEOLOGICAL SURVEY,
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THE ADHESION OF MERCURY TO GLASS

THE adhesion of *small* drops of mercury to the clean sides of glass vessels is a matter of common laboratory observation. It is seen in partly filled bottles of mercury that have been recently shaken, and it is often noticed in the glass chambers of mercury pumps. Yet larger drops break away leaving the glass "dry."

Observations on the "wetting" of clean surfaces of glasses of special constitution, as evidenced by the *rise* of the mercury meniscus against such surfaces when vertical, have been reported by Schumacher.[1] The observations reported here are of a totally different sort. The glass is that of ordinary laboratory lenses—probably crown glass as the index of refraction in each case was between 1.53 and 1.56. These were cleaned by rubbing the surfaces with a piece of absorbent cotton wet with absolute alcohol. The mercury was singly distilled, and to lessen contamination was transferred from vessel to vessel through a glass siphon that was started by a current of dry air. Before each set of observations the mercury was passed through a paper and cottonwool filter to free it from dust caught on its surface. The observations were made in the open air of the laboratory, so it will be evident that no claim for extreme cleanness of surfaces can be made.

If the surface of a glass lens, cleaned as described above, be brought into contact with a pool of mercury so that the lowest point (the apex) of the glass is say 0.2 mm. below the level of the mercury surface, the air adherent to the glass depresses the mercury in contact with it and holds it out of contact with the glass. After an interval, which may vary from a fraction of a second to several minutes, the fluid pressure seems to drive the air away from the apex of the lens and then, in a flash, a bright mirror spreads over the glass. This may be interrupted by a few small bubbles of imprisoned air. The edge of the mirror surface, or the "circle of extreme contact" of mercury and glass, is well above the general level of the mercury pool—a meniscus being formed at the edge of which the mercury is lifted a millimeter or more. As no reference to this phenomenon could be found in the literature available it was thought worth while to make some quantitative observations on it.

The disposition of apparatus is shown diagrammatically in fig. 1. *A* is the pool of mercury—about 18 cm

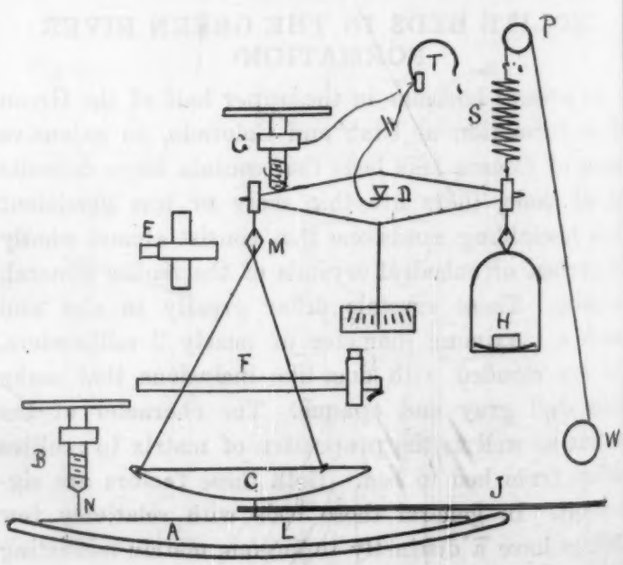

FIG. 1

across—in its shallow glass basin, *B* is a micrometer screw on a fixed stand by which the needle point *N* may be adjusted to contact with the surface of the mercury pool, and by means of which changes in the level of *A* may be followed. *C* is the lens of measured curvature, the lower surface of which is under observation. The lens is held in a frame of steel wires

[2] Burgess, P. S., and McGeorge, W. T., Zeolite formation in soils. SCIENCE, new ser., vol. 64, pp. 652–653, 1926.

[1] *Jour. Amer. Chem. Soc.* Vol. 45, No. 10.

that hangs from one hook of the balance arm *D*. Changes in the level of the lens surface may be measured by observing the displacement of the needle point *M* (rigidly attached to the steel frame) through the reading microscope *E* (scale vertical). The vertical motion of *C* is controlled by the micrometer screw *G* which acts directly on the balance arm *D*. *H* is a counterweight in the second pan of the balance to maintain contact between the balance arm and the point of the screw *G*. *J* is a strip of thin ebonite that carries at its end a "distance piece" *L* formed of 2 mm of the point of a needle. The top of *L* is held against the apex of the lens by the small stiffness of the ebonite strip *J* and the lens is then lowered until the point of *L* comes into contact with the surface of the mercury pool *A*. The reading of the level of the needle point *M* in this position together with the length of the distance piece gives a datum level from which the relative levels of the apex of the lens and the surface of the pool of mercury can be determined, account being taken of changes in the level of the pool itself as revealed by the reading of the screw head at *B*. The level of the pool is of course altered either by the immersion of part of the lens itself or by the drawing up of mercury into the meniscus. Fig. 2

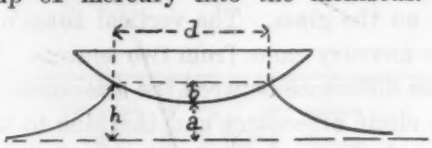

FIG. 2

shows the lens and the mercury meniscus. The diameter of the circle of contact (*d*) is observed *through* the lens by the reading microscope shown with scale horizontal at *F* (fig. 1). From this measurement and the known curvature of the lens the distance *b* (fig. 2) follows from geometry, and this with the distance (*a*) of the apex above the level of the pool gives the maximum lift (*h*) of the mercury in the meniscus.

With plano-convex lenses no correction for refraction in the observed value of the diameter of the circle of contact was necessary. For other lenses the value of *d* is obtained from the observed magnitude by the use of a curve in which the known distances of the points of a pair of micrometer calipers are plotted against their distances as observed through the lens by the microscope *F*, the points being held against the lower surface of the glass.

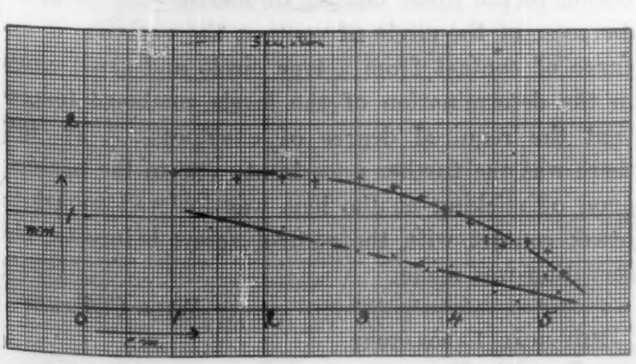

FIG. 3

In all cases within the range available the mercury rose above the level of the pool although the rise was less for circles of contact of larger radius. The rise on gradually lowering the lens into the mercury was always less than the rise found for the same circle of contact on lifting the lens out of the fluid. Fig. 3 shows the values obtained from a plano-convex lantern condenser of radius of curvature 10.41 cm[2]. The abscissae are radii of the circles of contact and the ordinates are the heights of the edge of the mercury meniscus above the general level of the pool. The values plotted in dots were found as the lens was slowly lowered into the mercury, the fluid rising over the clean glass. Those shown in crosses were from measurements made as the lens was gradually lifted, the fluid slipping back over surfaces that had been previously covered with mercury. The curve seems to indicate a vanishing value for *h* just beyond the limit of observation, at a circle of contact of radius 5.75 cm which would lead to an angle of contact for the mercury and lens used of nearly 147°. No test seemed feasible for the electrification of the freshly exposed surfaces, but usually *dry* glass plunged into mercury is strongly electrified on withdrawal. Whether the moisture of the summer air kept the surface sufficiently conducting to discharge it is not known, but the electrical grounding of the mercury pool produced no apparent difference in the results. All the curves obtained are of the same general nature with the one shown in the figure. With all of the lenses, independently of their particular curvature, the lift of the mercury at the edge of the meniscus was about 0.16 cm though with a sample of freshly distilled mercury a lift of 0.200 cm. was once obtained.

A noteworthy feature of the phenomenon was the way the mercury gradually passed from the circle of contact that had just been rendered unstable, by the lifting of the lens, to a new stable circle. Usually it would move fairly quickly and come to rest again within a minute or two; but when the mercury cov-

[2] The radius of curvature was found by rolling calibrated "bicycle balls" of different sizes into contact with the lens as it rested on a flat surface and then measuring the distance from ball to ball with a reading microscope. In Fig. 4 $R = \frac{D^2}{4r}$.

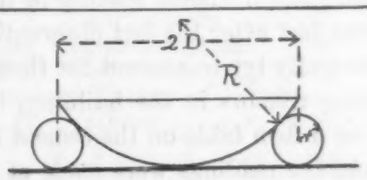

FIG. 4

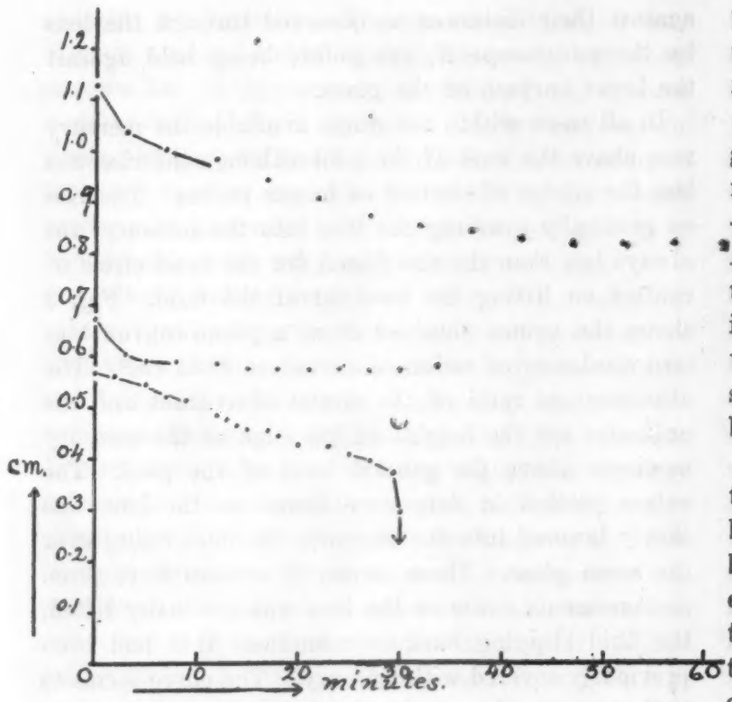

FIG. 5

ered only a small area near the apex of the lens it might be a half an hour or more before the new position was finally reached. Figure 5 shows some typical cases. The ordinates are radii of the circle of contact in cm and the abscissae are times in *minutes* from the first reading of the circle of contact after the lifting of the lens, the level of the lens being unchanged during the series of readings shown in the plot. Those plotted in the upper curve took over an hour to become stable. For the first of the series h was 0.161 cm and for the last 0.155 cm. In the final position the mercury seemed to be in a state of abnormal adhesion to the glass ("stuck") for a careful lifting of the lens through 0.003 cm did not alter the radius of the circle of adhesion, and this seemed *quite stable* at the increased height above the mercury pool. Another lift of 0.005 cm, however, started a rapid shrinking of the radius that led to the breaking of the meniscus in a few seconds. The middle curve is a record of the attaining of stability from a circle of radius smaller than that of the upper curve. The lowest line of dots shows a case where the contraction of the circle reached the point where it rapidly became more and more unstable, leading to the breaking of the meniscus just after the last observation plotted. One would naturally try to account for these peculiarities by invoking tremors in the building, but the apparatus was on a firm table on the cement floor of the laboratory, and the readings were made at night when the observer was alone in the building. Usually, as noted in connection with the upper curve of figure 5, after the circle had attained a stable position the lens might be lifted from 0.001 to 0.002 cm before the edge would be "pulled away from its moorings" to recommence its slipping over the glass to a new position of rest.

To measure the force exerted by the mercury on the glass the following additions were made to the apparatus. A light spiral spring S—from a Jolly balance—was attached to the second balance hook of the arm D (Fig. 1) and from its upper end a string ran over the pulley P to the small winch W. By means of this it was possible to exert small but definite forces upwards on the pan H until the contact between the screw point of G and the balance arm just broke, the break being indicated by the telephone circuit T.

The meniscus being formed, the winch was slowly turned until the contact at the point of G was just broken. The balance arm was then in equilibrium between the forces exerted by the mercury and those exerted by the masses suspended from the hooks and the force set up by the spring S. The screw G was then raised out of the way, the position of the pointer of the balance was noted, the levels and diameter of the circle of contact read, then the meniscus was broken and the change in the masses on the pan of the balance to restore equilibrium at the same pointer reading gave a measure of the force exerted by the mercury on the glass. The vertical force on the lens from the mercury came from two sources. First, that due to the difference between the atmospheric pressure over the circle of contact and that due to the smaller pressure of the mercury in contact with the glass. Second, there was the vertical part of the force due to the surface tension of the mercury around the circumference of the circle of contact. A series of measurements was made for different circles of contact and for different lenses, all of which led to the magnitudes to be expected from the known constants of mercury. These observations were of no use as determinations of the surface tension of mercury for the following reasons: (1) The value for the surface tension comes from the difference between the observed equilibrating force and the force due to the difference of pressures as noted above, and, except for the smallest circles of contact, these are too nearly of the same magnitude to give their difference much value. (2) Owing to the great density of mercury errors in the diameter of the circle of contact, the variation of the curve of contact from a true circle and small errors in the determination of the levels combined to prevent the required degree of exactness. Then, too, there was the further uncertainty due to the phenomenon of sticking as the lens was lowered enough to break contact with the control screw before the observation was made.

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SCIENCE NEWS

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MAN-LIKE FOSSIL REMAINS

EXTREMELY ancient fossil bones, which may be those of the Heidelberg race of man or of even earlier man-like creatures, have been found in the same region that yielded the famous Mauer jaw, the sole relic of this extinct human species so far accepted as authentic. The discoverer of the new fossils, Dr. Wilhelm Freudenberg, of Frankfort-am-Main, states in a communication to the British anthropologist, Sir Arthur Smith Woodward, that he has eighteen bone fragments of men or man-like apes, all collected in sand pits in the river deposits near Heidelberg.

One of the fossils, a shin-bone, is short, very heavy, and decidedly curved, resembling the corresponding bone in a gorilla. There is also the fragment of a thigh-bone with gorilline characteristics. A foot-bone shows some resemblance to that of a chimpanzee. Associated with other bones of undoubted apes and monkeys were several which Dr. Freudenberg states are more strongly human in their shape, and which he considers to be the remains of a forerunner of Neanderthal man.

Scientists in London are inclined to be somewhat conservative until all the evidence is in. *Nature* comments editorially: "Paleontologists and anthropologists will await with great interest Dr. Freudenberg's detailed description of his finds. Remains of monkeys of Pleistocene age are known from Norfolk, the Thames Valley, France and Germany, but no trace of the man-like apes has hitherto been discovered in Europe of later date than the lower Pliocene. If Dr. Freudenberg's results are confirmed, the search for the earliest ancestors of man in Europe is not so hopeless as it is commonly supposed to be."

A single tooth, declared by its finder to be human or at least human-like in character, has been dug up in China, in a geological formation of about the same age as the one in which the German fossils were discovered, Dr. Davidson Black, of Peking Union Medical College, reports. It was found by Dr. Birger Bohlin, a paleontologist attached to the Geological Survey of China, at the same site that last year yielded other fossils claimed to be human. Dr. Black states that the new find is a molar tooth from an individual in the same stage of development represented by that of an eight-year-old modern European child.

A DISAPPEARING ISLAND

FALCON ISLAND, in the Goro Sea, southwest of Apia, Western Samoa, and between the Fiji and Tongan Islands, is again above water after years of submergence. This is indicated by word received by Dr. Andrew Thomson, director of the Apia Observatory. Heralded by a slight earthquake on September 30, great columns of smoke were observed from Nukualofa in the Tongan Islands issuing from the sea on October 4. Three days later the site was visited by the British warship *Laburnum*, and a new island was found about 300 feet high at its central point and three miles in circumference.

Puffs of smoke shot up about every 20 minutes to a height of from 4,000 to 5,000 feet, the tops of the smoke columns being lost in the clouds. With each outburst ashes and cinders were thrown into the air, to fall back and build up the central cone. Late in the fall the island was reported to be erupting steam at intervals of about once a minute along its entire length.

"The island was discovered in 1865 by the British cruiser *H. M. S. Falcon*, when it was a low-lying reef," says Dr. Thomson. "In 1885 an eruption took place, which built up a cone, which in 1889, after four years' weathering, was found to be over 150 feet high. A slight volcanic outburst occurred in 1895. Since then the island, which was composed entirely of cinders and ashes, gradually slipped down into the sea.

"The area around the little South Sea Kingdom of Tonga is of great seismic activity. The earthquakes equal in intensity and frequency those of Japan. Some of the earthquakes are directly due to submarine volcanoes; others are caused by a readjustment of the earth's crust along a line of great ocean depths, which stretch from the Samoan Islands to New Zealand."

THE VIVARIUM IN PARIS

WHAT might be called an insect zoo has just opened in Paris where the public is turning its attention from the lions and tigers in the menageries to see the new vivarium in the Jardin des Plantes. Here it has the extraordinary experience of watching insects in their natural environments, each group shown in an indoor glass cage fitted up to seem like home to the inhabitants.

This somewhat unique accomplishment has not been so easy as it might seem. The insects come from various climates and their requirements are naturally vastly different. Thus a complicated heating system is necessary to simulate the African desert in one cage and a coolish temperature in the next. Heat, humidity and light have all formed tremendous problems solved by the ingenuity of Dr. Jeannel, director of the vivarium.

In some cases it has been necessary to fool the insects for the benefit of the public. In their desire to establish the closest possible contact with objects about them, the scorpions, if left to their own devices, would completely disappear from sight by burying themselves and leave the public to look at a seemingly empty cage. However, they seem very well satisfied to hide beneath plates of transparent glass through which they can easily be seen.

A pair of giant phasmas have shown that hens are not the only ones whose reproduction is affected by electric light. For two months they failed to reproduce, but the day an electric light was put in their cage they responded accordingly.

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Several cages are devoted to exhibits of insect mimicry. There are the giant phasmas just mentioned which look like the green leaves they feed upon, and others which exactly resemble the straw-colored branches to which they are clinging. The observer must watch closely for some movement to tell which is which.

The vivarium is for the purpose of exhibiting all cold-blooded animals in their natural environments, but the insect exhibits are the most unusual part of the program.

MOUNTAIN SHEEP IN YELLOWSTONE PARK

M. P. DOYLING, a government engineer, describes an interesting battle of bighorn mountain sheep he saw a short time ago in Yellowstone National Park.

"Although they were not more than fifty feet from the edge of the road, they didn't pay the slightest attention to the car I was in, and I sat for about fifteen minutes, and witnessed a most unusual and interesting sight," he reports.

"There were two young rams fighting an old and somewhat heavier one. What surprised me most was their method of attack in which they were 'true gentlemen.' They would stand about twenty feet apart and both start at precisely the same time, coming together, always, directly head on. Only after one has seen the size of the horns on the little animals and knows the speed at which they travel can one imagine the terrible shock it must be to them, at each such encounter.

"I expected to see them butt each other in the sides and rear, but in every instance they waited for the other to get set and then always came head on. After each such encounter they would stroll around for a minute or two, sometimes even taking a few mouthfuls of grass, before going through exactly the same performance again. If one tried to lie down, as did happen several times, the other would be over immediately and bother him until he got up.

"In one encounter one of the rams was on higher ground than the other but, apparently, to counteract this condition the one on the low side reared up on his hind legs and came down just in time to hit the other square in the center between the horns. After a bit one of the young rams strayed away a couple hundred feet and, after pawing away the dirt on the side hill, became, for the time being, an interested spectator. The other young one kept at the old ram, however, and every minute or two they would have another encounter.

"I doubt very much if the old ram could stand this relay of encounters for a great period as he was panting heavily and blood was coming from his nose when I left the scene of action."

VITAMIN D

VITAMIN D, the radiation-generated something that prevents the development of the bone-disease, rickets, in children and young animals, has been traced to a new source by Dr. Walter A. MacNair, of the U. S. Bureau of Standards, and Dr. C. E. Bills, of Evansville, Ind.

Recent research has shown that vitamin D is produced when a substance known as ergosterol is subjected to the invisible ultra-violet rays. Not the whole range of the ultra-violet is thus able to generate the vitamin, but only certain zones or bands of wave-lengths. These wave-length bands are also able to prevent rickets in young animals when turned directly on them, instead of on the food which is later fed to them.

Ergosterol is a comparatively new substance, which is extracted from cholesterol, a material that has been known for a long time. It occurs associated with the fats in animal bodies. It was formerly thought that cholesterol was the seat of vitamin D activity, but after the art of extracting the ergosterol from it was perfected, the cholesterol seemed to be inert and unable to form the vitamin even when subjected to ultra-violet raying. The conclusion, therefore, was that ergosterol could form vitamin D, and that the cholesterol from which it had been extracted could not.

But now Dr. Bills has been able to obtain some degree of vitamin D activity from cholesterol, freed from ergosterol, and on examining the effects of the rays with a spectrograph Dr. MacNair has found that certain wave-lengths of ultra-violet light are absorbed by it. This may indicate that cholesterol after all has some capacity for forming vitamin D, although Dr. MacNair inclines to the opinion that it is more likely that it still contains as an impurity another substance as yet unextracted and unidentified, possibly of the same order as ergosterol.

LOSS OF APPETITE AND VITAMIN B

PROFESSOR J. C. DRUMMOND, vitamin specialist, and Dr. S. K. Kon, of University College, London, have found that there is a close relationship between the amount of vitamin B in the diet and the total amount of food taken. Pigeons fed a diet adequate in all respects except that it lacked vitamin B gradually lost all appetite for the meals presented to them. Another group of pigeons kept under observation as controls, fed as much food as they wanted along with an ample ration of vitamin B, grew healthily and retained normal appetite. A third group, fed only the amount of food that the first group actually ate plus a plentiful supply of the vitamin in question, showed loss of weight due to slight starvation.

From their results, Professor Drummond and Dr. Kon concluded that the loss of weight that is always associated with lack of vitamin B is simply caused by partial starvation; the pigeons lose their appetites and refuse to eat the deficient food, and hence lose weight.

Since vitamin B occurs in only minute quantities in different foods its presence becomes of increasing importance. Consequently an elaborate study of this question has been taken in hand at the chemical department of St. Thomas's Hospital Medical School, London, by Dr. R. H. A. Plimmer and his colleagues. They tested a number of cereals by feeding them to pigeons for a long period. They found that none of the cereals examined contained such a rich amount of vitamin B as dried yeast. Wheat, barley and rye contained more vitamin B than maize or oats. These investigators, like

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Professor Drunmmond and Dr. Kon, found that young animals need more vitamin B than adults and that the first important symptom is loss of appetite, which leads to loss of weight.

COFFEE AS A BEVERAGE

COFFEE drinkers will welcome the tidings, announced by Professor Ralph H. Cheney, of the biology department of New York University, that coffee is not only harmless but beneficial.

"Evidence derived from my study of the effect of coffee on animals and man," Professor Cheney declared recently, "indicates that the properly prepared beverage is highly advantageous with respect to over 90 per cent. of normal individuals. Judging from the effect of aqueous solutions of caffeine or of the coffee beverage taken through the stomach in the 1.5 grain quantities such as exist in the average coffee cup, the reasonable use of coffee is a great blessing to man. To be sure, caffeine is a drug and its use can be abused, but acute injury, as far as the caffeine content is concerned, would necessitate the consumption of over 150 cups which is, of course, ridiculous.

"Psychological responses of amiability and a sense of well-being and good cheer are undeniable accompaniments of the coffee beverage and the physiological effects are also non-injurious and gratifying. Temporary relief from hunger and fatigue is a general result, and light headaches, due to other than gastric disturbances, are commonly alleviated. Coffee serves as a mild stimulant of the heart, brain and muscles, thereby accomplishing greater power and coordination in mental and physical endeavors.

"The outstanding fact to be heralded in favor of coffee is the absence of any after effect or subnormal, recuperation period. It does not seem to be habit-forming since satisfactory stimulation does not require continually enlarged quantities. No other beverage produces equal stimulation without deleterious after-effects. On this basis, it is safe to say that coffee, prepared by subjecting the ground bean to water just below the boiling-point for 5 minutes or even somewhat longer in most household percolators, is not injurious to adults in normal health who show no acute idiosyncrasy regarding caffeine or other substances in the beverage."

Coffee is an impressive example of a plant, Professor Cheney pointed out, whose economic importance has been raised to great heights by its successful planting in a locality entirely foreign to its natural distribution since it is indigenous to Africa and Asia and is raised principally in Brazil and Colombia. The United States is the largest consumer, coffee imports being exceeded only by sugar and raw silk.

ITEMS

THE cotton crop losses from the boll-weevil in 1927 were about 1,487,000 bales, according to estimates reported to the American Association by Dr. R. W. Leiby, of the North Carolina Department of Agriculture. Losses sustained by the states of Texas, Arkansas, Florida, Georgia, South Carolina, Mississippi, Louisiana and North Carolina amounted to $148,700,400, Dr. Leiby declared. "The unusual injuries caused by the weevil during 1927," the entomologist explained, "are attributed to a rapid multiplication of the weevils under favorable weather conditions, the climate during the summer in most sections of the cotton states having been only moderately warm and rather rainy."

THE corn borer has spread its domain in Canada over 95,650 square miles, according to L. S. McLaine and H. G. Crawford, entomologists of the Canadian Government. An outbreak was discovered at New Liskeard, Ontario, practically the northern limit of corn growing and 380 miles north of the original outbreak in southern Ontario. Infestation in Quebec is still less than one per cent., but has increased in Ontario. The pest has not yet been found in Nova Scotia or New Brunswick, it was stated. Control operations in Ontario were, on the whole, a success, but were seriously handicapped by a wet spring and fall.

FOWLS that have been rendered completely sexless are substantially identical, regardless of their original sex, Dr. Lincoln V. Domm, of the University of Chicago, reported at the meeting of the American Association. Hens, deprived of their characteristically feminine organs, develop rooster-like plumage, spurs and small combs, but never attempted to crow, the scientist stated. In general they resembled capons both in behavior and appearance except for their consistently smaller size.

HUGE mounds of snail shells are evidence that prehistoric men in North Africa depended chiefly on snails for food, according to Dr. George L. Collie, director of the Logan Museum of Beloit College, speaking to anthropologists at the meeting of the American Association. A shell mound 300 feet long and eight feet high has been excavated by an expedition from the Logan Museum. Among the snail shells and kitchen ashes of the dump piles are found some bones of animals and once in a while a human skeleton. Excavators also unearthed flint arrow points and scrapers and hammer stones lost or thrown away by Stone Age men and women thousands of years ago. Small bone tools with fine, delicate points are the most common of the bone implements in the shell mounds, and some archeologists believe that they were used as picks or forks to remove snails from their shells.

MANHATTAN'S smoke screen cuts out 42 per cent. of the morning sunlight. At noon the loss is 18 per cent. The figures for this indictment of the smoke nuisance in large cities have been compiled by experts of the U. S. Public Health Service. Loss of efficiency from decreased lighting is not the only result of excessive smoke in manufacturing centers. It also cuts out to a large extent the ultra-violet rays necessary for good health. The importance of getting rid of smoke is emphasized for the preservation of eyesight and health generally, as well as for the prevention of accidents. On foggy days the loss of light runs even higher than the figures quoted.